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The Mississippi River Waterway: An Alternative Route for Canadian Grain Exports?

An Overview of the Mississippi River Transportation System

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THE MISSISSIPPI RIVER WATERWAY
AN ALTERNATIVE ROUTE FOR CANADIAN GRAIN EXPORTS?

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AN OVERVIEW OF
THE MISSISSIPPI RIVER TRANSPORTATION SYSTEM

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FOREWORD

Recent reports have suggested the Mississippi River as an economical alternative to the traditional Great Lakes and St. Lawrence River routing for Canadian eastbound export grain. The comparative analysis reported here leads to the conclusion that the Mississippi is unlikely to offer an economical long run alternative for Canadian shippers. Further, to the extent that it might capture traffic in the short run, it poses the threat of higher total transportation costs for traffic remaining on the Great Lakes/Seaway System.

This volume consists of two parts. The first identifies a possible routing for Canadian grain to reach tidewater on the lower Mississippi, briefly describes the costs and rates that might apply to such a movement, and compares these to figures for the Great Lakes/St. Lawrence System. The second part, prepared for the Research Branch by Peter Yee of the University of Toronto/York University Joint Program in Transportation, provides information upon which the first section draws, especially with respect to the costs of towboat and barge operation.

This document is made available for discussion and analysis as part of the ongoing Research Branch program of studies into grain transportation. The opinions expressed are those of the authors, and not necessarily the views of the Canadian Transport Commission. The Branch welcomes comments on its work, which in this case should be addressed to the undersigned at (819) 997-6025 or Mr. A.W. Gemmell, at (819) 997-6541, or in writing to the Research Branch, Canadian Transport Commission, Ottawa, Canda K1A 0N9.

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Introduction

The availability of a low cost route to export Canadian grains, and other products from the Canadian west, is of vital interest to the whole of Canada. Perhaps due to institutional arrangements, attention has been focussed on all-Canadian routes through west coast ports and the Great Lakes and St. Lawrence Seaway system. However, some have felt that the American Mississippi River system could be a viable alternative.

This brief report deals with the direct costs that might have to be borne by shippers of Canadian grain in moving their product through the United States, using the Mississippi River Waterway System.

It builds on another report contracted for by the Research Branch of the Canadian Transport Commission during the course of 1986. This earlier work was done by Peter Yee of the University of Toronto/York University Joint Program in Transportation, and is appended in its entirety. The present report takes the information accumulated by Yee, extends his work in some areas, and meshes it in such a way that it is possible to estimate a range of costs that might occur for the movement of Canadian grain on the Mississippi.

The Route and Basic Logistics

The route considered for this movement is the following. It is assumed, to minimize the effort while providing as realistic a picture as possible, that grain would be loaded into barges from rail cars at a facility in St. Paul, Minnesota. From there it would travel down the Mississippi River to Baton Rouge, Louisiana at which point it would be transfered to an elevator for loading into an ocean vessel. For these purposes, a hypothetical water transportation system is postulated: it consists of three sets of 15 barges each operating on the Upper Mississippi River, and one barge train of 45 barges operating on the Lower Mississippi.

To get the grain to St. Paul, it is anticipated the grain would travel by rail via the Burlington Northern or the Soo Line from a Canadian

interchange point. Winnipeg is considered the likely origin of the grain, although it might well originate elsewhere on the eastern prairies. To provide grain for such an operation would require moving some 68000 tons of grain every two weeks. On rail, this would probably require the use of six 75 car trains of 100 ton hopper cars.

Rail Haul and Costs

The logic behind estimating the possible rail cost for such a movement follows. The distance from Winnipeg, chosen as the hypothetical origin of the movement, to St. Paul is about 450 miles. The distance from Winnipeg to Thunder Bay, Ontario, the major eastern rail terminus for Canadian grains, is very comparable, being slightly under 440 miles. Thus, rail rates applying for the movement from Winnipeg to Thunder Bay could be considered as a first estimator of what rates might apply to a movement to St. Paul.

It is fair to note that one must exercise great care in extending Canadian rail rates to rail transportation in the United States, because of the need to interline the traffic at the border, and due to the fact that an American carrier will handle the traffic onwards to destination, and the American carrier operates under very different institutional and regulatory arrangements than apply to Canadian railways and especially rail grain carriers operating in Canada. Canadian rail rates for export grain are regulated to ensure that, on average all grain transportation under the Western Grain Transportation Act, the railways recover variable costs plus a 20 percent contribution to overhead costs and profit.

As a further caveat, one should note that the rate that applies to the Winnipeg to Thunder Bay movement may or may not be profitable in itself, depending on the costs of operating over the lines in question and the extent to which the costs on this line may be lower than those for grain service through the mountains, to the north, or on grain dependent branch lines. On the other hand, a rate set for a movement from Winnipeg to St. Paul would be

established to be profitable to the carriers solely on the basis of its own costs and competitive situation rather than those of the system as a whole.

Given these cautionary notes, the rate in 1986 for the Canadian movement is Can$21.25 per metric tonne. That is the equivalent of Can$19.28 per short ton, and, assuming a Canadian/American dollar exchange rate of Can$1.00=US$0.72, of US$14.90 per short ton. This rate would apply in Canada whether the shipment was made one car at a time, or in large multiple car lots, such as 75 or 100 car trains of 100 ton hopper cars.

For guidance on the possibilities of unit or solid train operations, one can look at tariffs quoted for multiple car movements offered by Canadian railways and American lines. One example is the rate quoted by Canadian National Railways for a very limited period during the grain handlers strike in Thunder Bay in September, 1986. In that case the single car rate for flaxseed from Thunder Bay to Superior, Wisconson was 1240 cents per ton, while the multiple car rate (minimum 75 cars per train) was 1070 cents per ton.*1 The reduced rate was 86 percent of the single car rate.

In their report on The Role of Trucking in the Grain Industry*2, IBI Group notes that the reduction offered by the Burlington Northern Railroad for a similar distance was from $23.59 per tonne (single car) to $19.18 (52 car unit) or to 81 percent of the single car rate.

Given this guidance, one perhaps could safely think that there might be a rate reduction possible of 15 percent or more for the size of the movement contemplated on the Mississippi River system, and applying that to the US$14.90 per short ton estimated above, the rail rate from Winnipeg to St. Paul could be about US$12.70 per short ton. The WGTA rate fixing process renders academic speculation concerning a competitive rate for solid trains to Thunder Bay, but there is no reason why it should not be competitive.

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*1 CNR Tariff (Limited) W 11102 and CNR Tariff (Limited) W 11116.

*2 IBI Group, February 1985, page 96.

The Barge Operation

For estimating the unit costs of transportation on the Mississippi River itself, a hypothetical, but realistic, operation is assumed. It would be the use of six fifteen barge trains with three 4000 hp towboats for use on the Upper Mississippi River from St. Paul to Cairo, Illinois and one 10000 hp towboat for use on the Lower Mississippi from Cairo to Baton Rouge. It is fortunate for cost estimation purposes that the operating times on each part of the river would be about the same, or about 15 days. On the Upper Mississippi, it is assumed the sailing time would be about 12 days for 840 miles, loading would be done in 5 days, and there would be between 2 and 3 days overall delay time at locks. On the Lower Mississippi, the total cycle time for about 720 miles would be about 14 days made up of 10 days sailing, unloading for 5 days, and 3 days to interchange barge trains at Cairo. Accordingly, seven cargo cycles in a 240 working day year (eight months ice free in the Upper Mississippi River) would be reasonable. Thus, it would be possible to move a little less than 1 million tons of grain.

To cost this type of system, use was made of the costs provided by Yee in Exhibit 5.7. It has been estimated that it would cost about US$4 million to build a 4000 hp towboat, and about US$8.5 million for a 10000 hp towboat. The cost per 1500 ton covered hopper barge would be about US$0.2 million. The details of the capital and operating costs and the investments needed are shown in Table 1.

Table 1: Costs and Investment in Towboats and Barges
(US$ 000)

		Capital	Annual Operating
Towboat Costs	4000 hp	4000	2600
	10000 hp	8500	4664
Barge Costs	1500 ton covered barge	220	11
Investment:	Towboats	20500	
	Barges	19800	
	Total	40300	
Operating Costs:	Towboats		12464
	Barges		990

Source: Yee 1986, page 05.

The treatment of the costs of capital in each of eight cases is shown in Table 2.

Case 1 is the base case, in which construction is assumed to be financed 85 percent by debt at 8 percent, and 15 percent by equity at a 30 percent cost of equity capital. Cases 2 and 3 vary the cost of equity capital from 30 to 20 and 10 percent; Case 4 varies the proportion of debt to equity to 25/75 percent, using 8 percent cost of debt and 20 percent cost of equity as a base; Cases 5 and 6 vary the cost of debt from 12 to 16 percent, reverting to the original debt/equity proportions, and a cost of equity capital of 20 percent. Case 7 gives an indication of the effect of not requiring a return on equity capital supplied to finance the operation. Case 8 recalculates the operating costs assuming that the fuel costs would be one half of what Yee estimates they were in 1985 (reflecting the significant decline in petroleum prices since January 1986).

Table 2: Cost of Capital

Item	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Tax rate	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Percent equity	0.15	0.15	0.15	0.25	0.15	0.15	0.15	0.15
Percent debt	0.85	0.85	0.85	0.75	0.85	0.85	0.85	0.85
Cost of debt	0.08	0.08	0.08	0.08	0.12	0.16	0.08	0.08
Cost of equity	0.30	0.20	0.10	0.20	0.20	0.20	0.00	0.20
Number of years	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Cost of capital after tax	0.07900	0.06400	0.04900	0.08000	0.08100	0.09800	0.03400	0.06400
Capital recovery factor	0.10110	0.09004	0.07956	0.10185	0.10261	0.11586	0.09673	0.09004

Source: Based on Yee 1986, page 64.

The application of these Costs and Investments from Table 1 and the Capital Cost information from Table 2 to the overall annual costs and the costs per ton is to be found in Table 3. This is based on an annual movement of 945,000 tons.

Table 3: Costs of Movement (US$)

Item		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Annual Costs:	Capital:	4074330	3628612	3206268	4104555	4135183	4669158	2810119	3628612
	Operating:	13454000	13454000	13454000	13454000	13454000	13454000	13454000	9908000
	Total:	17528330	17082612	16660268	17558555	17589183	18123158	16264119	13536612
Costs per ton:	Capital:	4.311	3.840	3.393	4.343	4.376	4.941	2.974	3.840
	Operating:	14.237	14.237	14.237	14.237	14.237	14.237	14.237	10.485
	Total:	18.548	18.077	17.630	18.580	18.613	19.178	17.211	14.324

The costs presented in Table 3 are in themselves largely self-explanatory when reviewed in conjunction with the description of the cases. However, there are a couple of points worth noting. Regardless of the source and costs of financing the barge operation, it is clear that operating costs

are less than 75% of the total only in Case 8, in which the cost of fuel are assumed to be 50% of the 1985 price. While this may not be an unreasonable assumption in December 1986, the long term is less certain.

In the same vein, Case 7 explores the level of costs if no return on equity capital were to be required. This reduces the capital costs by about 35% from the base case, but only reduces the total cost by 9%. Capital costs are not the most significant element in determining the costs of barge and towboat operation on the Mississippi.

The costs computed above are estimates of the long run cost that would have to be recovered for the operator to remain in business and continue to invest in similar equipment. Clearly, for a variety of reasons such as traffic development, operations balancing, retention of skilled labour, a need just to show activity or the flag, excess capacity, etc., operators choose to accept in the short run rates far below those needed to cover full costs. For example, should an operator choose to cover only fuel and wages on a given trip, the rate per ton might be as low as US$10.00, and if fuel cost 50% of the 1985 price, as low as US$6.25. However, this could be only a short term situation, and in the longer term, either the system would deteriorate or there would be compensating periods of higher rates.

An important departure between economic cost and the costs calculated here must be noted. The Mississippi River system is maintained by the American government without direct charge to its users, although a small portion of the costs is recovered through fuel taxes. It is a legitimate question whether in the long term the United States will be willing to provide a subsidized transportation system for the use of a competitor in international grain markets.

Terminal Operations and Costs

Preliminary investigation of loading costs at St. Paul reveal that for annual volumes in excess of 100,000 tons, operators would charge about US$1.25 per ton. It is worth noting that there are some assumptions built

into the weighing and sampling system for such an operation. It is assumed that rail weights for grain would be accepted, and that the grain would not have to be weighed on loading into the barges. On the other hand, sampling and grading could be done at the terminal, at extra cost. In quoting this rate, the terminal operator assumed an operation involving no storage on his part, but rather a "direct hit" transfer from unit train to barge. The assumption is that three unit trains of 75 cars of 100 tons each would be needed to fill a fifteen barge tow. To transship this volume would take between one and two operating days. The operator contacted felt that to load three barge tows in a reasonable length of time was beyond the capacity of his plant, but pointed out that there were several similar operations in the vicinity of his terminal, and he thought they would be competitive.

A conversation with a terminal operator at Baton Rouge indicated a transhipment (barge to vessel) rate for of US$0.70 to US$1.40 per ton could be arranged depending on volume, type of grain, and time of year. According to Yee, loading and unloading tariffs are about the same, and his estimate for loading charges were between US$1.75 and US$2.50 for occasional shipments. This range was confirmed by a terminal operator in St. Paul.

The rates quoted for high volume movements through terminal and transfer on the Mississippi system are very attractive (similar rates at Thunder Bay and Quebec would be Can$5.24 and Can$2.40). It is to be borne in mind that the Mississippi system quotations are traffic development rates for incremental volumes, rather than long term rates for base loads, and that in the Canadian system more than transfer and loading is provided. Moreover, in Canada both primary (country) and terminal elevators are owned by grain companies, and it may be that their system of receiving and handling grain for their own account and for the Canadian Wheat Board is done on an overall basis, rather than on trying to make each element a separate profit centre. Thus, the Canadian terminal and transfer elevation charges used here may well include an above average contribution to overheads and profits. The American system, as a rule, involves independent operations.

Overall, one can assume that the two transfer systems would provide comparable services at competitive rates.

Deep Sea Shipping Cost

Brief comparison of dry cargo voyage charter rates to European, African, and South American destinations between May 1985 and April 1986 for grains and meals from the lower St. Lawrence with those from the US Gulf does not reveal any clear picture of advantage to one route over the other from tidewater port to destination port.*3

Comparison with all-Canadian Eastern Route

The competitiveness of a Mississippi routing for Canadian grain exports should be viewed from two perspectives. First, what could be achieved from a short term diversion, and second, what are the net benefits to Canadian producers as a whole from a system adjustment towards the Mississippi route. From the first perspective, a bulk grain shipper (about one million tons per year) might achieve the costs shown in Table 4.

Table 4: Cost Summary: Mississippi Route

	US$/ton	Can$/tonne
Rail costs from Winnipeg to St. Paul	US$12.70	Can$19.45
Terminal costs at St. Paul *i	1.25	1.90
Barge costs from St. Paul to Baton Rouge	14.30	21.90
Terminal costs at Baton Rouge *ii	1.25	1.90
Total costs	US$29.50	Can$45.15

*i includes elevation as needed and outward loading.
*ii includes elevation and outward loading.

*3 Drewry Shipping Consultants Ltd. Shipping Statistics and Economics.

As shown in Table 4, this cost of US$29.50 would be approximately the equivalent of Can$41.00 per ton (at an exchange rate of 0.72) and Can$45.00 per (metric) tonne. If the full cost (in 1985) for fuel were used (Case 1, Table 3), this would translate to about Can$51.50 per tonne. The shipper might achieve even lower costs over the short run if the carrier were prepared to price his services below long run variable cost. Such circumstances, and these exist today, occur legitimately in highly cyclical industries where to be strategically placed for the next upturn an operator must continue operations at rates sometimes even below short run available cost. These conditions underlie the rate quotations that have drawn recent Canadian attention to the Mississippi route.

By way of comparison with Table 4, the 1985/86 crop year costs on the Canadian route from Winnipeg to Thunder Bay, Ontario by rail, terminal handling at Thunder Bay, bulk laker to the Lower St. Lawrence at Quebec, and transfer handling at Quebec are shown in Table 5 (using the same elements included in the Mississippi System calculation).

It should be noted that the rates of terminal and transfer elevation in the two situations are not completely comparable, in that certain functions are provided or required in Thunder Bay and the lower St. Lawrence, and included in the rates, but have not been provided for at St. Paul or Baton Rouge. These include sampling and weighing.

Table 5: Cost Summary: Seaway Route

	Can$/tonne
Rail costs from Winnipeg to Thunder Bay	Can$21.25
Terminal costs at Thunder Bay *i	5.24
Vessel costs from Thunder Bay to Quebec	19.77
Transfer costs at Quebec *ii	2.40
Total costs	Can$48.66

Source: Canadian Grains Industry Statistical Handbook 86, Table 51, Page 198.

*i includes elevation, outward weighing, inspection, terminal elevator receipt cancellation, and lake shippers' charges.

*ii includes elevation, outward weighing, inspection, superintendence, wharfage, and forwarding brokerage charges.

From the second perspective mentioned above, that of the long run for a major shipper, one can conclude that railway costs from Winnipeg to Thunder Bay should be roughly equivalent to or slightly lower than those from Winnipeg to St. Paul; that Canadian terminal costs should differ little from those on the Mississippi system (and in fact lakers ought to be somewhat easier to handle for loading and unloading than barge trains of a comparable capacity); and that average ocean shipping costs should differ little. The focus is, therefore, on the vessel charges for the Mississippi route and the Great Lakes/Seaway route - Can$21.90 per tonne for the Mississippi and Can$19.77 for the Seaway, or about ten percent in favour of the Seaway route.

The margin in favour of the Seaway route due to the lower vessel charges may well be increased by other factors. For example, the Mississippi costs presume a continuing large infrastructure subsidy while the Seaway rates include tolls to make the system self-sustaining. Another source of potential risk for Canadian shippers on the Mississippi is that the rates are subject to fluctuations in the Canadian/American dollar exchange rates.

Conclusion

It appears that the Mississippi route may only be a transitory opportunity for Canadian grain shippers to reach world markets. Moreover, a decision to use this route must also weigh more than the immediate dollar benefits, and include an assessment of the general benefit to the Canadian economy of using a Canadian route. Part of that assessment must be the costs of maintaining an underutilized route in the expectation that diverted traffic may return. For example, the fixed costs of maintaining the Great Lakes/Seaway system (both infrastructure and vessels) are significant, and would have to be borne by the remaining users of the system.

Attention must be paid to distortions in Canadian pricing mechanisms that might lead to commercially, rather than economically, justified diversion of Canadian grain traffic to the Mississippi route.

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1. Introduction

During the last few years, Canada's freight transport environment began to change fundamentally and rapidly. The change began with the economic recession of 1982 and the subsequent passage of the Western Grain Transportation Act. Since then the economy has recovered, but the recovery has been characterized by slow and uneven growth and deflationary tendencies. In addition, the federal government in 1986 started to negotiate free trade with the U.S. The weak economic environment has already put considerable pressure on the transport industry and this is expected to continue for a while. Furthermore, the new government policies will begin to affect carriers and shippers differently in the near future. As a result, industry will go through a period of adjustment during which uncertainty may arise and its ability to manage in the new environment may be severely tested.

One question of significant interest in this context is the competitive position of Canada's principal distribution channels. Some claim that because of the new rail rate structure set by the Western Grain Transportation Act, the western route will be favoured by grain shippers. Others believe that the seaway route is less reliable, as evidenced by the interruptions to navigation in recent years, inherently more costly and, therefore, not competitive. There are even those who fiercely contend that the northern route through the Port of Churchill has merits of a strategic nature. Conspicuously, the attention has been focussed entirely on routes in Canada and not on others which use U.S. ports as points of export. In this regard, the major waterway on the Mississippi River constitutes an alternative, since this is a system that could be made available to Canadian shippers.

The Mississippi River and its tributaries are a major distribution channel in the U.S., facilitating the movement of about 350 million tons of commodities annually. This level of traffic activity is almost equal to the

total Canadian marine traffic of 380 million tons per annum in recent years. The main stem of the Mississippi starts from Minneapolis, Minnesota and ends 1,700 miles downriver at the Gulf of Mexico. Along the way, barges pushed by towboats carry bulk commodities of various kinds, of which the principal ones are coal, grain and petroleum products. The head of navigation at Minneapolis/St. Paul, Minnesota is about 450 miles from Winnipeg, Manitoba and U.S. rail connections are available at the interchange in Emerson, Manitoba through the Burlington Northern Railway and the Soo Line Railway. At the present time, potash from Saskatchewan destined for the U.S. and Brazilian markets moves on the waterway.

The interest in the Mississippi River, from the Canadian standpoint, lies in the prospect that the waterway may be an economical route with potential cost savings for shippers of western Canadian bulk commodity exports. This is particularly true at a time when the margins of commodity producers are under significant pressure from falling commodity prices and when Mississippi barge rates are at very low levels. The appeal of the Mississippi must, however, be accompanied by a basic understanding of the short and long term market trends on the waterway. For instance, low rates in a weak barge market in the short term may give way to higher rates in the long term and, as a consequence, what may appear now to be a cost advantage in favour of the Mississippi may not be the case later on. Therefore, there is a need to understand the dynamics of the Mississippi waterway so that the major trends can be discerned. Accordingly, this report is concerned with three particular areas: (i) the economic and institutional factors that govern the waterway; (ii) the market trends that may emerge; and (iii) the implications for Canadian carriers and shippers.

The report is organized into seven sections. Section 2 provides an overview of the U.S. inland waterway system in terms of history, existing network and usage in order to highlight the significance of the Mississippi. This is followed by Section 3 which describes the Mississippi River System in some detail by covering topics such as physical characteristics, navigation

technology, locks and canals, principal ports, and institutional arrangements so as to provide some understanding of the infrastructure in place and the way the river is managed. Section 4 discusses traffic on the waterway in terms of commodity flows, trade patterns and barge traffic. Since the towboat and barge industry is an important element in the system, Section 5 gives an account of the industry in terms of ownership structure, fleet size and age, tug and barge costs, and market conditions. Due to the particular problems of the industry and the rapidly changing environment on the waterway, issues and trends are discussed in Section 6. Finally, the report concludes with Section 7 by discussing the potential implications for Canadian transportation if traffic is diverted to the waterway. Throughout the report, monetary values are expressed in U.S. dollars.

2. Overview of U.S. Inland Waterways

In the domestic trade of the United States, carriage by water accounts for approximately 20 percent of total tonnage, compared to highway motor carriers, rail, pipelines and air which account for 36, 27, 17 and less than one percent respectively. Domestic waterborne commerce can be classified as ocean, inland waterways, and Great Lakes, depending upon which waters were exclusively or jointly navigated during the movement. In 1983, the total amount of domestic waterborne trade was 968 million tons, with 322 million tons (33 percent) on the ocean, 557 million tons (58 percent) on inland waterways and 89 million tons (9 percent) on the Great Lakes. These statistics indicate the relative importance of water carriage in domestic trade and the significance of inland waterways in waterborne commerce.

U.S. waterways are generally classified into two major sectors consisting of (i) the Great Lakes and (ii) the inland, intracoastal and coastal channels sheltered from the severe wave action of the open lakes and seas. The Great Lakes system is an international deep-draft waterway where the U.S. section extends more than a thousand miles from Duluth in Lake Superior to the Thousand Islands at the entrance of the St. Lawrence River on the eastern shore of Lake Ontario. By contrast the inland, intracoastal and coastal waterways are primarily shallow-draft, essentially consisting of three separate systems covering more than 25,000 miles of commercially navigable waters: (i) the Atlantic Coast; (ii) Mississippi-Gulf; and (iii) the Pacific Coast. (See Exhibit 2.1 on page 9).

In this overview, the existing network of inland waterways will be described and the traffic levels for the different sections of the network will be presented. By way of leading into the overview, the history and development of waterways is provided in the next section.

2.1 History and Development

The continent's abundant rivers and lakes in their natural state were often swift, shallow, subject to dangerous flooding, and filled with

obstructions of many types that did not easily lend themselves to commercial navigation. Colonists who explored and settled in the continent drew upon their experience of European technology to overcome the obstacles encountered. Initially, the coastal ports were the first to be developed and these were established on estuaries that were deep enough for ships of the day. As ship drafts increased, the commerce at shallow-draft ports gradually declined. Although the problem was overcome in the short term by the use of lighters and by ships waiting for high tide, the inconvenience became a disadvantage. Deep-draft ports, especially those with ready access to the interior, saw their commerce increase and flourish.

The colonists discovered the hazards of river navigation as they moved into the interior. They realized that navigation could be made safer by constructing canals along sections of the river where slackwater could be found. About the same time, Europe was experimenting with canals for commercial navigation and the influence also spread to the colonies. Soon after, the colonies and later the States embraced the concept with enthusiasm as a way of developing the vast resources of the American frontier. Thus began the era of canal building in the late 1700s which reached a peak by 1830. After the peak, canal construction went into decline when the State of Pennsylvania declared bankruptcy and by the mid-1800s the period of development came to an end.

During this period, a total of about 4,000 miles of canal were built primarily by state and private interests, and these were located mainly in the northeast and midwest. The canals were used primarily for transporting Pennsylvania coal and grain from the midwest to ports on the Atlantic seabord. Some of these canals were highly successful and achieved national significance, such as the Erie Canal linking New York City to Lake Erie via Buffalo, but most were only of local importance.

The men who provided the engineering skills in the construction of canals came from the Corps of Engineers of the U.S. Army. Formed in 1779, the Corps of Engineers initially provided engineering talent in support

of the national defense, but their responsbilities extended to navigation works when the federal government established control over the navigation system through the Northwest Ordinance in 1787. When the canal building period began, the Corps carried out the federal role by removing obstructions from rivers, providing canals for passage around falls or rapids, and improving channels for navigation to ensure safety. After the canal building period came to an end, Congress gave the Corps, in progressive stages, the authority to reconstruct existing navigation structures whenever safety and operation was at risk, to construct new navigation projects when specifically authorized, and to repair, rehabilitate, and replace existing structures on the waterway. These responsibilities of the Corps continue to the present day.

Navigation technology during the early period consisted of canoe, flatboat and keelboat, which allowed downstream transportation of agricultural and fur goods. Later in 1807, the arrival of the steamboat was a major technological development which enabled upstream as well as downstream navigation, and steamboats came to be used on all navigable rivers. Steamboats carried passengers and also became the major source of domestic freight transportation for mail, general cargo in the form of bags, barrels and bales, and bulk goods. Open-topped barges began to appear on the river to carry coal and they were either towed by steamboats or left free-floating. It was only after the end of the canal building era in the 1850s that towboats, specially designed to push loaded barges lashed together as a single unit, emerged on the scene. This was a major technological advance in the large scale handling of bulk cargos on the river.

By the time of the American Civil War in 1861, rail had emerged as the dominant mode of transportation for passengers and general cargo. Rail was generally regarded safer, faster and could travel further inland and as a result steamboats gradually began to disappear from the waterways. The towboat and barge system, however, was better able to withstand the competition from rail and, as a result, commerce on the waterway was confined mainly to bulk cargos.

The dominance by the railroads continued to increase and by the turn of the century began to take its toll on river traffic in bulk trades. States and private interests, who were largely responsible for investing in the waterway, decided to ease themselves out of the river business and the federal government stepped in to gain control. For instance, facilities on the Monogahela River, a tributary of the Ohio River, were acquired from private interests and tolls were lifted. Navigation on most rivers at this time was limited to three to six feet, and the need for greater depth was already becoming apparent. In response to the need, Congress in 1910 authorized a comprehensive lock and dam system for the entire Ohio River. A similar comprehensive system on the Illinois River was authorized by Congressional Acts beginning in 1917. Other authorizations to deepen the navigation channels also followed, which for instance included the Cumberland River, a tributary of the Ohio.

River traffic during the years just prior to World War I declined and the momentum for river improvements disappeared. The lumber market on the Upper Mississippi River collapsed, coal movements practically ceased down the Ohio and Lower Mississippi Rivers to the Gulf Coast as petroleum replaced this trade, and the grain trade to New Orleans suffered from rail competition in the Upper Midwest. When World War I began, U.S. industry joined in the war effort and the declining traffic trend began to reverse. The war effort led to shortages in rail and water equipment and, as a result, the government formed the Inland Waterways Corporation to promote water transportation. By the end of the 1920s, the Ohio project was completed, a six-foot channel had been constructed on the Cumberland, and plans for comprehensive lock and dam systems were underway on the Illinois and the Upper Mississippi to increase navigation depths on these rivers from six to nine feet.

In the 1930s the Great Depression dampened all economic activity. However, the perceived advantages of public works investment in rejuvenating the economy led to a considerable number of new river projects designed not only to promote navigation, but also for hydroelectric power

generation, flood control, recreation and other purposes. Much of the modern nine-foot navigation system in place today can be traced to projects begun or completed during this period.

When World War II came, the waterway system was much better prepared to play a strategic role than it had in World War I. After the war, the transportation industry grew at an unprecedented rate. To meet the increased demand, a new series of projects were undertaken in the 1950s and 1960s. The locks and dams of the Ohio were consolidated, as 13 new high level locks replaced 39 of the original 50 facilities. New locks and dams were also built on the Cumberland River, and larger lock chambers were begun at sites on the Tennessee River. Additional facilities were being added to accommodate modern tow sizes on the Black Warrior-Tombigbee and Monogahela Rivers, while new projects were launched to extend navigation up the Columbia and Snake Rivers in the Pacific Northwest and up the Arkansas River into the state of Oklahoma. Finally, in 1972 the Tennessee-Tombigbee Waterway project was initiated and thirteen years later the project was completed. The opening of the Tennessee-Tombigbee Waterway in 1985 marks the completion of the waterway system as it is known today.

2.2 Existing System

The major inland waterways of the U.S. are composed of a number of river systems which can be classified as the Mississippi River System, Gulf Coast Waterways, Atlantic Coast Waterways, and West Coast Waterways (See Exhibit 2.1). These major systems consist of various tributaries where the navigable channels vary in length and depth (See Exhibit 2.2). A brief description of each system is provided below by way of indicating the extent of inland waterways in the U.S., and the significance of the Mississippi River in this network. The Mississippi in turn is described in greater detail in Section 3.

The major inland river transportation system of the U.S. is the Mississippi River and tributaries, which include the Ohio River System, the

Exhibit 2.1

Major Inland Waterways in the U.S.

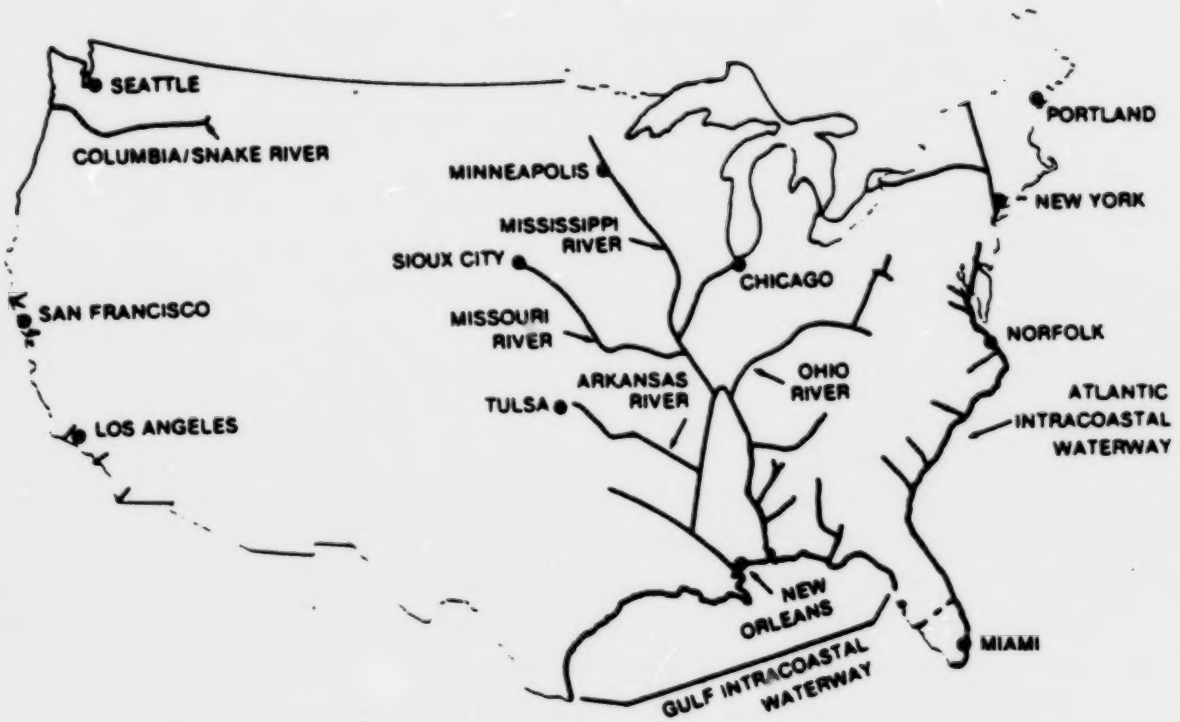


Exhibit 2.2

Commercially Navigable Waterways of the United States by Lengths and Depths[1]

Group	- Lengths in Miles of Waterways - Under 6 ft.	6 to 9 ft.	9 to 12 ft.	12 to 14.ft.	14 ft. & Over	Total
Atlantic Coast Waterways	1,426	1,241	584	938	1,581	5,770
Atlantic Intracoastal Waterway-Norfolk,V.A.,to Key West, Florida	-	65	65	1,104	-	1,234
Gulf Coast Waterways	2,055	647	1,133	79	378	4,292
Gulf Intracoastal Waterway-St. Marks, Fl. to the Mexican Border	-	-	-	1,137	-	1,137
Mississippi River System	2,020	969	4,957	740	268	8,954
Pacific Coast Waterways	730	498	237	26	2,084	3,575
Great Lakes	45	89	-	8	348	490
All Other Waterways	76	7	-	1	7	91

1 The mileages in this table represent the lengths of all navigable channels of the United States, including those improved by the federal government, other agencies, and those which have not been improved but are usable for commercial navigation.

Source: U.S. Department of Transportation. Domestic Waterborne Trade of the United States 1979-1983 Maritime Administration, U.S. Department of Transportation.

Illinois Waterway, and the Arkansas and Missouri rivers. In this system, which runs north-south, there are approximately 9,000 miles of improved navigable channels, 65 percent of which have nine-foot channel depths or more. Navigation on the Mississippi River stretches roughly 1,700 miles from its mouth at the Gulf of Mexico, through New Orleans and Baton Rouge, to Minneapolis/St. Paul at the head of navigation. Major tributaries of the river extend the network both east and west. On the east, the Ohio with important navigable tributaries of its own, reaches 980 miles northeastward from its junction with the Mississippi at Cairo, Illinois, to Pittsburgh, Pennsylvania, where the river is formed at the confluence of the Allegheny and Monongahela rivers. Major navigable tributaries of the Ohio include the Tennessee, Cumberland, Green, Kentucky, Kanawha, Allegheny and Monongahela rivers. Some of these tributaries serve commercially important hinterlands of their own which contribute significant traffic to the Ohio and Mississippi systems as a whole. Also to the east, but further north, the Illinois Waterway, another critical tributary of the Mississippi, joins the Mississippi just above St. Louis with the Great Lakes at Chicago, 357 river miles away, and creating a water link between the industrial northern tier of states along the Great Lakes and the interior of the country served by the Mississippi River System. On the west, extensions of the Mississippi system includes the Missouri River and the McClellan-Kerr Arkansas River Navigation System. The Missouri reaches 735 miles west and north from the Mississippi at St. Louis to Sioux City, Iowa while the Arkansas River system reaches 448 miles westward from the Mississippi to Catoosa, Oklahoma, near Tulsa.

In contrast to the north-south orientation of the Mississippi system, the Gulf Intracoastal Waterway (GIWW) runs parallel to the coast for 1,099 miles from Canabelle, Florida to Brownsville, Texas on the border with Mexico. The GIWW is a series of natural waterways linked by canals which intersects the Mississippi River at New Orleans. To the east of New Orleans, the GIWW carries traffic from the Mobile River and its tributaries as well as others such as the Apalachicola - Chattahoochee - Flint system. To the west, the GIWW carries traffic from many points, a branch of which

reaches the Mississippi River at Baton Rouge, the Atchafalaya River, the Houston ship channel, and other smaller canals and channels.

The two systems - the Mississippi River and tributaries and the GIWW - constitute a network which connects some of the largest ports in the Gulf Coast (e.g., New Orleans, Houston, Baton Rouge, Beaumont, Corpus Christi and Mobile) to some of the largest inland and Great Lakes ports (e.g., St. Louis, Pittsburgh, Cincinnati, Memphis, Chicago, Detroit and Duluth). The network is home to the largest tug and barge operations in the world. Furthermore, the section of the Mississippi River from Baton Rouge to the Gulf of Mexico is open to ocean shipping, thus making this part of the inland waterway system vital to the domestic and foreign trades of the U.S.

On the Atlantic Coast, deep draft waterways carry most of the waterborne commerce while shallow draft waterways carry much less. Deep draft waterways in this system are located adjacent to deep-sea ports, and they include Cape Cod Canal, Cape Fear River below Wilmington, Chesapeake Bay, Chesapeake-Delaware Canal, Delaware River and Bay, Hudson River below Waterford and the James and Potomac rivers. Shallow draft waterways connect Atlantic Coast ports and deep draft channels with areas further inland, but most of these rivers are not long and serve only a limited area. The total length of the Atlantic Coast Waterways is 5,800 miles. Also as part of this system is the Atlantic Intracoastal Waterway (AIWW) which is a partially protected coastal water route suitable for commercial tows and other light draft vessels between Massachusetts and Florida. The length of the AIWW is about 1,200 miles.

Finally, on the Pacific Coast, principal inland shallow draft navigation is on the Columbia/Snake Waterway, which connects Lewiston, Idaho, with deep water at Portland, Oregon, and then meets the Pacific at Astoria, 465 miles downriver from Lewiston. Further south, the Sacramento and San Joaquin rivers provide deep-draft navigation from the major ocean ports of Oakland and San Francisco to the inland ports of Sacramento and Stockton, California. The total length of the Pacific Coast Waterways is 3,600 miles.

2.3 Usage

The use of inland waterways in previous years is shown by the tonnages of waterborne commerce tabulated in Exhibit 2.3. As shown, the tonnage increased from 191 million in 1950 to a peak of 535 million tons in 1979 and 1980, before declining to 489 million in 1983. The composition of tonnages is shown in Exhibit 2.4, where coal is the leading commodity, followed by petroleum products, and crude pretroleum. The amount of coal moved shows a steady increase from 58 million tons in 1953 to 131 million tons in 1982. Petroleum products, which includes gasoline, jet fuel, distillate fuel, and residual fuel oil, increased from 52 million tons in 1953 to 113 million tons in 1977, but decreased to 88 million tons in 1982. Crude petroleum increased from 24 million tons in 1953 to 60 million tons in 1972. After 1972 crude petroleum traffic declined to the 1982 level of 35 million tons. Grains, on the other hand, have shown substantial growth in the last quarter century, increasing almost 15 fold from four million tons in 1953 to 69 million tons in 1982.

The tonnage by shipping area in recent years is shown in Exhibit 2.4 The Mississippi River System is by far the most heavily used waterway, accounting for approximately 350 million tons, followed by the Gulf Intracoastal System with about 103 million tons. The Atlantic Coast Waterways and Pacific Coast Waterways have much lower tonnages.

Exhibit 2.3

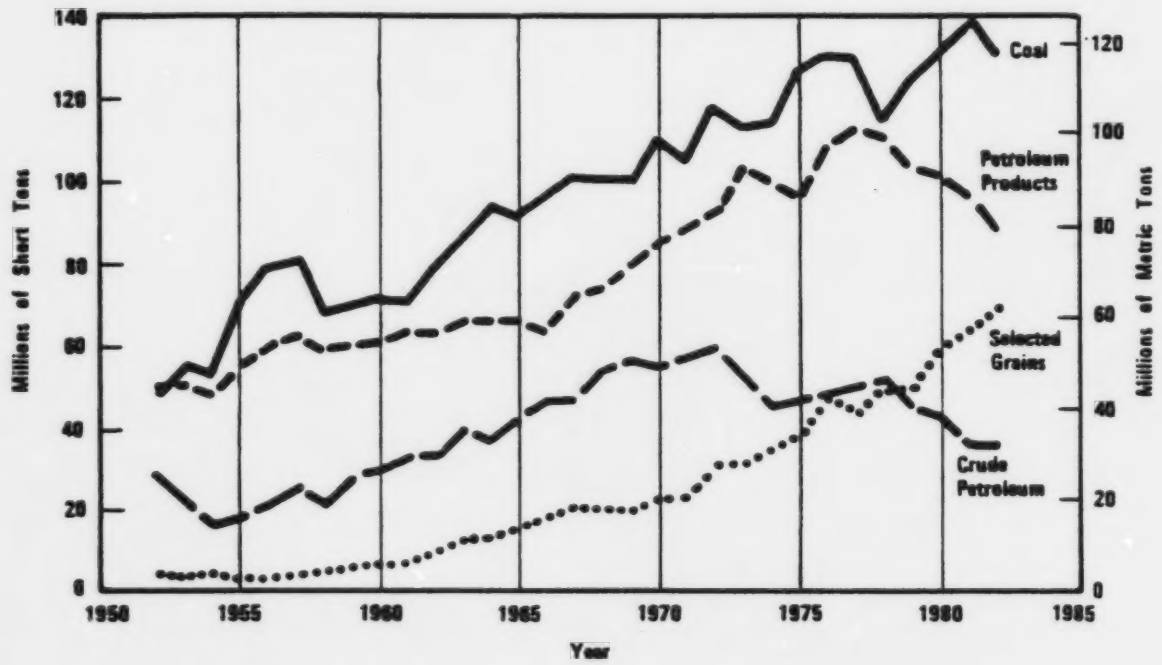
U.S. Inland Waterway Commerce

Year	Tons (Millions)
1950	191
1960	291
1970	472
1979	535
1980	535
1981	521
1982	495
1983	489

Source: U.S. Army Corps of Engineers. Waterborne Commerce of the United States, Part 5, National Summaries.

Exhibit 2.4

Leading Commodities in U.S. Domestic Waterborne Commerce on Inland Waterways, 1952 - 1982



Source: U.S. Army Engineer Institute for Water Resources. United States Inland Waterways and Ports, 1985

Exhibit 2.5

U.S. Inland Waterway Traffic by Region

(000 Tons)

	1979	1980	1981	1982	1983
Atlantic Coast					
North Eastern	69,632	67,815	67,074	60,384	57,737
Atlantic Intracoastal	59,044	50,619	466,699	37,581	36,989
Gulf Intracoastal	119,346	109,812	116,751	104,517	102,734
Mississippi River System	370,757	365,569	362,930	347,474	351,953
Pacific Coast					
Pacific Northwest	47,372	49,936	42,656	41,120	35,320
California	5,345	8,714	14,872	16,383	14,669

Source: U.S. Department of Transportation, Domestic Waterborne Trade of the United States 1979-1983. Maritime Administration, Washington, D.C., 1985; and Department of the Army Waterborne Commerce of the United States - 1983. Corps of Engineers, New Orleans, U.S, 1985.

3. The Mississippi River System

As noted in the previous section, the Mississippi River system is the largest and most developed component of inland waterways in the U.S. The river system is 4,000 miles in length, consists of 250 tributaries, and includes almost half of the navigable waters of the U.S. It starts modestly in northern Minnesota, at its source in Lake Itasca, and gathers strength as it flows southward 2,552 miles into the Gulf of Mexico. Along the way it is joined by the Illinois, Missouri, Ohio, and Arkansas rivers and their tributaries. The navigable channels of the system stretch 1,700 miles from the head of navigation at Mineapolis/St. Paul through St. Louis and New Orleans to the Gulf of Mexico, serving many inland ports and terminals along the way.

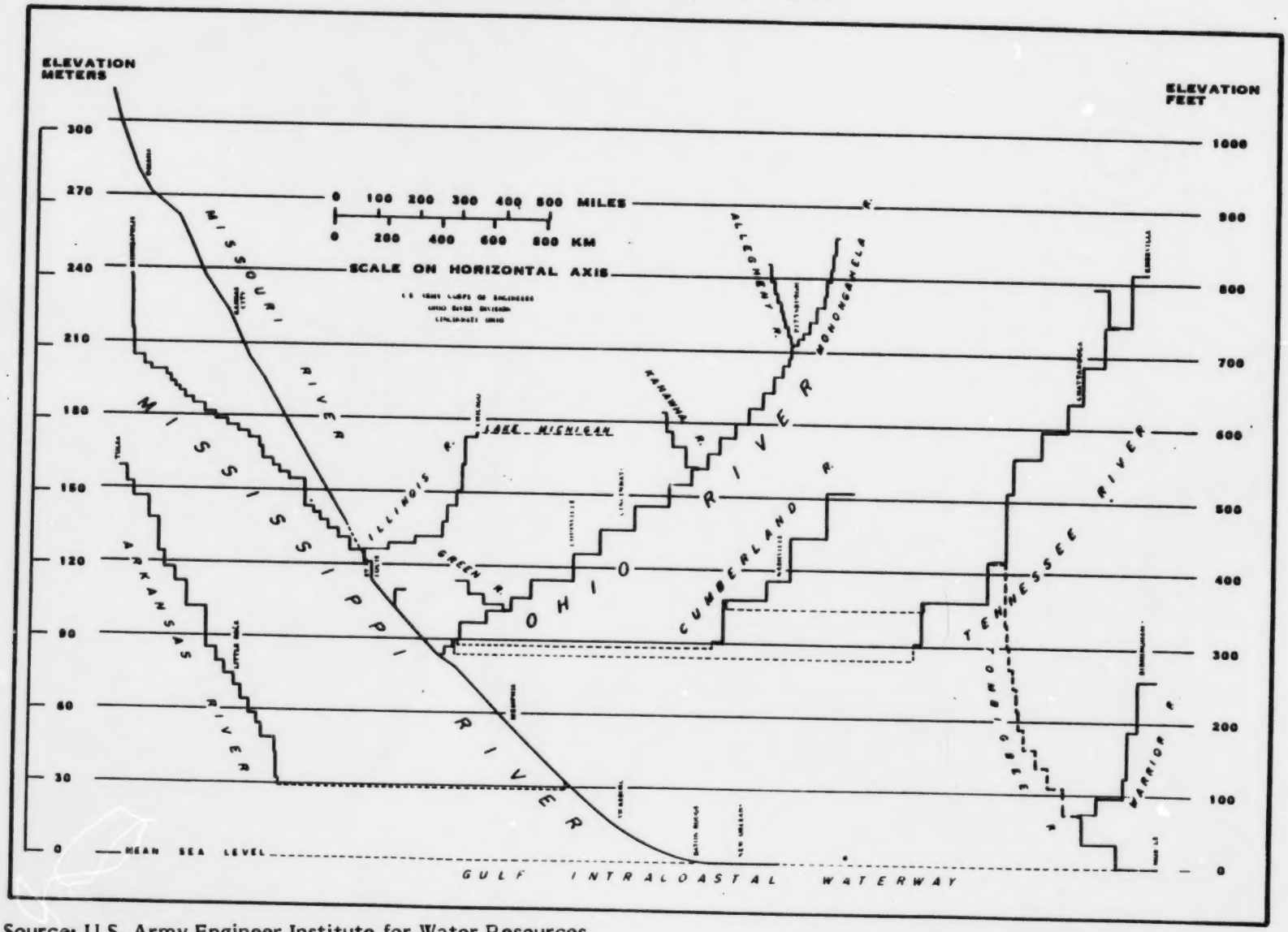
In this section, the Mississippi River System will be examined more closely to identify its major characteristics and capabilities. Essentially, the focus of attention is on infrastructure (i.e., locks and canals, ports and terminals), navigation technology and equipment, and institutional arrangements. The section begins with a review of the physical characteristics of the river.

3.1 Physical Characteristics

An elevation profile of the Mississippi River and its major tributaries is shown in Exhibit 3.1. In the case of the Mississippi River, the elevation from sea level at the head of navigation in Minneapolis is nearly 800 feet. As the Mississippi flows southward, the elevation drops progressively, at first through a series of 27 locks to an elevation level of 380 feet near Cairo and then through open-channel to sea level in the Gulf of Mexico. Along the way, major tributaries such as the Missouri River, Illinois River, Ohio River, and the Arkansas River join the Mississippi at declining levels of elevation. The elevation profile of each of these tributaries in relation to the Mississippi is also shown in Exhibit 3.1.

Exhibit 3.1

Elevation Profile of Mississippi River System



Source: U.S. Army Engineer Institute for Water Resources.
United States Inland Waterways and Ports, 1985

A description of the characteristics of the river system is provided below. A summary of these characteristics is also shown in Exhibit 3.2.

Upper Mississippi River

Navigation on the Upper Mississippi River extends 637 miles north from the mouth of the Illinois River to Minneapolis, Minnesota. The navigable depth of nine feet is provided by a series of 27 locks and dams, together with channel works and dredging. This section has the greatest number of locks on the Mississippi River, and it was developed mainly during the mid-1930s. Winter ice conditions limit the general navigation season to eight months above Hannibal, Missouri, near Lock and Dam 22. Dredging is required in order to maintain a nine-foot navigation channel.

Lower Upper Mississippi River

The Lower Upper Mississippi extends 220 miles from the mouth of the Ohio River at Cairo, to the mouth of the Illinois River. There is an open-channel section from Cairo to Lock and Dam 27 near St. Louis. Above this point the river is canalized to the head of navigation near Minneapolis, Minnesota. Lock and Dam 26, just downstream from the junction of the Illinois and Mississippi rivers, is currently the major constraint to traffic flow in the Mississipi system; a single 1200-foot replacement lock is now under construction. Dredging and locks and dams are used to maintain authorized channel dimensions of nine feet by 300 feet in the Lower Upper Mississippi. The open-channel design of most of the Lower Upper Mississippi, that is without locks and dams, involves the use of stone dikes, bank revetment for stabilization, and dredging.

Lower Mississippi River

Open-channel navigation exists between the mouth of the Mississippi and Baton Rouge, Louisana, and between Baton Rouge and Cairo, Illinois, at the mouth of the Ohio River. The channel between Baton Rouge and Cairo is presently maintained to the nine-foot depth by channel stabilization works and dredging; however, a 12-foot depth is available during most of the year.

Exhibit 3.2

Operating Characteristics of the Mississippi River System

River Section Name	Description	Controlling Depth (ft).	Controlling Width (ft.)	Length (miles)	Navigation Season
Upper Mississippi River	Minneapolis, Minnesota to Mouth of Illinois River	9	200-300	637	8 to 9 months
Lower Upper Mississippi River	Mouth of Illinois to Cairo, Illinois	9	200-300	220	Year-round
Lower Mississippi River	Cairo to Baton Rouge, Louisiana	9-12	300	723	Year-round
	Baton Rouge to Gulf	40	500	233	Year-round
Illinois Waterway	Lake Michigan to Mississippi River	9	110-160	357	Year-round
Missouri River	Sioux City, Iowa to Mississippi River	8.5-9	250-300	735	8 months
Ohio River System	Ohio River	9	240-300	981	Year-round
	Cumberland	9		381	Year-round
	Green and Barren	9		150	Year-round
	Kanawha	9		91	Year-round
	Allegheny	9		72	Year-round
	Monongahela	9		129	Year-round
	Tennessee	9	150-250	652	Year-round
	Kentucky	9		259	Year-round
McClellan-Kerr Arkansas River Navigation System	Catoosa, Oklahoma to Mississippi River	9	250	448	Year-round

Source: U.S. Army Corps of Engineers, Institute for Water Resources.
National Waterways Study - A Framework for Decision Making - Final Report, 1981

In addition, a width of 300 feet is also maintained for navigation. This 823-mile stretch is perhaps the most significant of the shallow draft inland waterways, carrying heavy traffic in both directions between deepwater ports at Baton Rouge and New Orleans and important upriver coal and grain producing areas of the Illinois, Ohio and Upper Mississippi Rivers.

Between Baton Rouge and the mouth of the Mississippi, a deepwater channel is maintained to a 40-foot navigable depth, permitting ocean-going vessels to navigate 233 miles upstream to the Louisiana capital. The combination of deep and shallow draft waterborne commerce makes this river waterway the busiest in the inland waterway system. The major ports of Baton Rouge and New Orleans play very significant roles in transhipping barge freight to ocean-going vessels and vice versa.

Ohio River System

In terms of total waterborne commerce, the Ohio River is the most important tributary of the Mississippi. The Ohio River, formed by the confluence of the Allegheny and Monongahela rivers at Pittsburgh Pennsylvania, flows southwesterly 981 miles to join the Mississippi near Cairo. The Ohio drains a great industrial, agricultural and coal producing basin of 204,000 square miles. The major rivers in the Ohio River basin, which have been improved for navigation, include the Ohio River itself (981 miles), the Cumberland (381 miles), the Tennessee (652 miles), the Green and Barren rivers (150 miles), the Kanawha (91 miles), the Allegheny (72 miles), and the Monongahela (129 miles).

Modernization of the navigation facilities on the Ohio River commenced during the 1950s, and the nine-foot navigation channel depth is now provided at 20 sites by locks and dams. During this modernization program, thirteen high-lift locks (i.e., lift of 12 to 16 feet) replaced 39 old low-lift locks (i.e., lift of 6 feet or less) and dams. The lock at Gallipolis has become a congestion point for waterborne commerce on the Ohio. Navigation on the major tributaries of the Ohio, has also been improved by locks and dams to provide nine-foot navigation channels.

Illinois Waterway

The Illinois Waterway is the second most significant tributary of the Mississippi River in terms of waterborne commerce. The waterway is located entirely within the state of Illinois and it connects Lake Michigan with the Mississippi River.

The Illinois Waterway is part canal and part canalized river. It leaves Lake Michigan at Chicago from two points, the Chicago River and the Calumet River, and then flows 326 miles in a southwesterly direction to enter the Mississippi River about 38 miles above St. Louis. Total length of the navigable waterway is 357 miles, which includes separate channels to Lake Michigan. Various Congressional authorizations, have resulted in the construction of a nine-foot by 300 foot navigation channel for most of the Illinois Waterway by means of eight locks and six dams, canals and dredging.

Missouri River

The Missouri is navigable for 735 miles from Sioux City, Iowa to its confluence with the Mississippi above St. Louis. A 300-foot wide by nine-foot deep navigable channel is authorized by Congress and generally an eight to nine-foot depth is maintained except during low flow periods. Navigation is open-channel, and the water level is maintained by releases from the upstream lakes. Navigation is available over an eight-month season, due to limited availability of water from upstream reservoirs and winter ice. There are no locks and dams on the river.

McClellan-Kerr Arkansas River Navigation System

The Arkansas River rises in the Rocky Mountains and flows southeastward through Colorado, Kansas, Oklahoma and Arkansas to join the Mississippi 599 miles above its mouth. The McClellan-Kerr Arkansas River Navigation System, authorized in 1946, was opened to waterborne commerce in 1970. The system provides a nine-foot navigation channel, 100 to 300 feet wide and about 448 miles long, on the White, Arkansas and Verdigris rivers to Catoosa, Oklahoma, near Tulsa. A lift of about 420 feet is achieved by 17 locks and dams.

The White River above the junction with the McClellan-Kerr system is also maintained for navigation. Currently a minimum depth of 4.5 feet and bottom width of 100 feet are maintained through snagging, dredging and some construction works.

Other Tributaries

There are several smaller rivers in various stages of improvement for navigation which connected with the Mississippi River System. These include the Atchafalaya River, Ouachita and Black rivers, and the Red River.

Atchafalaya River extends from the Gulf Intracoastal Waterway at Morgan City, Louisiana to the Mississippi River. The navigable channel has a depth of 12 feet and a width of 150 feet. Use of this channel shortens the distance between the Gulf of Mexico and the Mississippi by 172 miles and eases congestion in the Port of New Orleans.

The Ouachita River has a nine-foot channel that extends upward for 208 miles from the junction of the Old and Red River Lock and Dam 6.

The Red River Waterway was authorized to improve navigation between the Mississippi River and Shreveport, Louisana. Construction began in 1983 and the plan was to provide a navigable channel nine feet deep, 200 feet wide and 210 miles long, utilizing five locks and dams. Lock and Dam 1 was completed recently.

3.2 Navigation Technology

As discussed previously, the use of towboats pushing a group of barges lashed together had supplanted the keelboat and the steamboat as the common way of moving freight on the waterway. Today, the same concept is still being used, and the tug and barge industry on the Mississippi has become one of the largest in the world. The current technology is much improved since the early period, and in the process steam power has been supplanted by the diesel motor, the stern-wheeler by the multiple-screw

propulsion, and intermittent operation subject to fog, darkness and low water by continuous movement 24 hours a day. Communication by radio-telephone has enhanced safety, improved service to shippers and increased the utilization of equipment. A modern tow of barges today carries up to 50,000 tones with a crew of a dozen or less, is in constant movement, whether upstream or downstream, in all kinds of weather 24 hours a day.

In many ways, the inland waterways owe its success to the technological features of the towboat and barge concept. This concept is quite different to ocean and Great Lakes shipping, where the economy of movement is accomplished by the use of high-tonnage vessels. High-tonnage vessels have a deep draft and, as a result, the limiting channels of deep sea ports and harbours are some 20 to 40 feet deep, while on the Great Lakes the navigable channels are 26 feet deep. By contrast the navigable channels of the inland waterways are only, for the most part, nine feet deep. This problem is overcome on the waterway by designing high-tonnage vessels which spread over a broader surface of water instead of drawing deeper levels of water.

Consider, for example, a lake vessel with a cargo capacity of 30,000 tons and a draft of 27 feet. It would require 20 standard barges (195 feet by 35 feet each), with a nine-foot draft, to carry this tonnage. At waterline the lake vessel occupies about 53,690 square feet of surface. Combined with their towboat, the 20 barges occupy 141,328 square feet, 2.6 times as much. Confined to only nine feet of depth in comparison with the lake vessel's 26 feet, one might infer that, to accommodate the same tonnage, the barge tow would require three times as much surface area instead of the actual 2.6. However, river barges and towboats utilize the waterway surface more efficiently because they do not have to be designed for the rough waters of the open lakes and oceans. In short, the tonnage of the vessel unit on shallow water is made just as great as that on the deep by spreading it out over a greater surface.

The multiple-barge tow solves the problem of how to manoeuvere a huge, space-consuming vessel unit in the narrow channels and confining locks of the rivers. The twenty-barge tow described above occupies 3.2 acres of waterway surface. Channel widths are only some 250 to 300 feet on major rivers, often as little as 100 feet on tributaries. Lock dimensions are even more confining, commonly 600 feet by 100 feet, and often smaller. The barge tow which, carries 30,000 tons consists not of a single vessel but of 20 carrying 1,500 tons per barge. The 20 barges are readily rearranged for movement through channels of varying widths when necessary.

For control in narrow and winding channels, tows must be pushed rather than pulled. A pulled tow of 20 barges, each floating freely on its towline, would be impossible to control in the narrow river channels and around sharp bends. Moving downstream in the river currents, there would be no way to stop it. By contrast, when the 20 barges are lashed snugly together with cables, the towboat at the stern, the entire unit is operable as though it were a single vessel, passing other tows at close quarters in narrow channels, held in the channel around sharp bends, and brought to a stop by reverse propulsion.

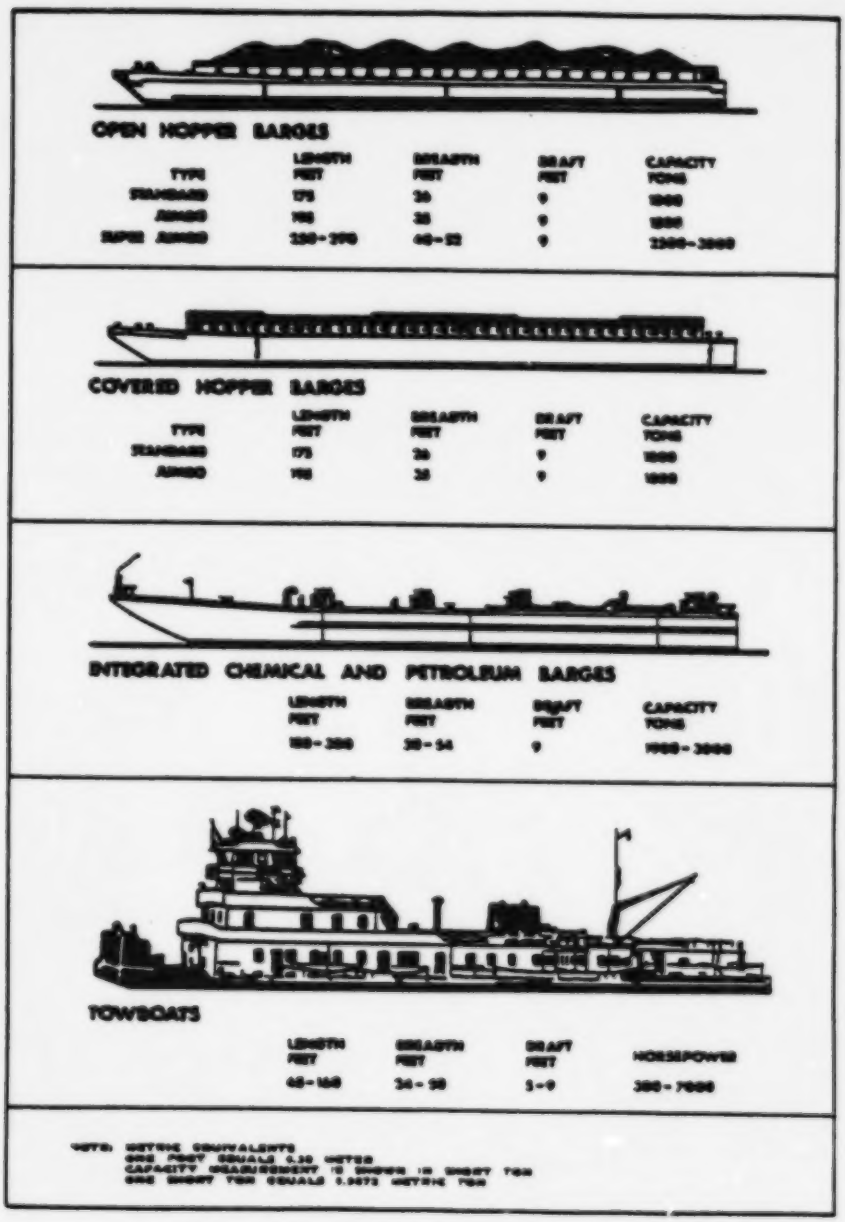
Four types of barges are commonly used on the waterway: open hopper, covered hopper, deck, and tank. The open and closed hopper and tank barges, as well as the standard towboat, are shown in Exhibit 3.3. The maximum tow size by different sections of the river system is shown in Exhibit 3.4. In practice, tows vary greatly in size and the average number of barges per tow is about eight. Coal tows of 20 to 24 barges are frequent, while some tows may consist of a single barge. Tows of up to 45 barges can be found on the lock-free Lower Mississippi River below Cairo, Illinois. Mixed tows, including barges of different types and sizes, are also commonly encountered.

3.3 Locks

By way of an overview, a summary of the locks on the Mississippi River System is shown in Exhibit 3.4. Most of the locks are found on the Ohio River System, totalling 57 altogether, and on the Mississippi River

Exhibit 3.3

Tug and Barge Types



Source: U.S. Army Engineer Institute for Water Resources. United States Inland Waterways and Ports, 1985

Exhibit 3.4

Locks on the Mississippi River System

River Section		Locks			
Name	Description	Total	Capacity (M. tons)	Age in 1985	Maximum Tow Size
Upper Mississippi River	Minneapolis, Minnesota to Mouth of Illinois River	27	9-67	22-63	15
Lower Upper Mississippi River	Mouth of Illinois to Cairo, Illinois	5	30-158	12-47	25
Lower Mississippi River	Cairo to Gulf	-	-	-	45
	Ouachita & Black Rivers	4	26	2-13	
	Red River	1	22	0	N/A
	Old River	1	60	22	
	Baton-Rouge-Morgan City	2	27-35	24-34	
Illinois Waterway	Lake Michigan to Mississippi River	8	27-49	25-52	15
Missouri River	Sioux City, Iowa	-	-	-	9
Ohio River System	Ohio River	20	35-214	5-64	15
	Cumberland	4	19-43	12-21	
	Green River	3	46	29	
	Kanawha	3	20-26	51	1-9
	Allegheny	8	16	47-58	
	Monongahela	9	11-95	21-78	
	Kentucky	14	6	68-141	15
	Tennessee	10	7-61	2-58	
McClellan-Kerr Arkansas River Navigation System	Catoosa, Oklahama to Mississippi River	17	25-31	15-18	9

Source: U.S. Army Corps of Engineers, Institute for Water Resources. National Waterways Study - A Framework for Decision Making - Final Report, 1981.

(excluding tributaries such as Ouachita, Black, Red and Old rivers) which has 32 locks. Other sections of the river system, such as the Illinois Waterway and the McClellan-Kerr Arkansas River System, have far fewer locks each (8 and 17 respectively), while the Missouri River has none. Exhibit 3.4 also shows the relative age of the locks and it is shown that the Ohio River System generally has the oldest locks on the waterway, followed next by the Mississippi River.

The condition of locks on the waterway is shown in greater detail in Exhibit 3.5 for selected river systems such as the Upper Mississippi River, Ohio River, and the Illinois River. The Exhibit shows specifically the age, traffic, capacity range and delay associated with each lock. The following is a commentary on each of the selected river systems.

Upper Mississippi River

Twenty-three of 27 locks are currently more than 45 years old. According to the Army Corps of Engineers, 19 of the 27 are scheduled for, or have received, major rehabilitation estimated to cost about $200 million. The Corps also estimates that for the rest of this decade, one-quarter of the major lock rehabilitations on inland waterways will be allocated to the Upper Mississippi.

The most heavily used locks are Lock 27 and Lock 26, with tonnages of 77 and 71 million respectively. Lock 27 has a much larger capacity range of 142 to 158 million tons, while Lock 26 has a capacity range of only 70 to 75 million tons. As a result, Lock 26 which is located below the confluence of the Mississippi River and the Illinois River has become one of the main pressure points on the waterway. All traffic is affected by the delays at this lock, especially for the downbound movement of agricultural products and the upbound movement of coal. A first replacement lock (110 ft. x 1200 ft.) has been authorized by Congress and completion is scheduled for 1988, while a second lock (110 ft. x 600 ft.) has been initiated in 1985. When completed, the two locks will be the same sizes as those at Lock 27, but the capacity range will be 92 to 100 million tons.

Exhibit 3.5

Locks on Selected Waterways

Waterway & Lock	Age (1985)	1984 Traffic (million tons)	Capacity Range (million tons)	Delay per Tow (Hr.)'84
Upper Mississippi				
27	27	77	142-158	.9
26	47	71	70-75	8.9
25	46	36.2	59-60	3.3
24	45	36.0	59-60	3.0
22	47	34.6	50	2.9
21	47	34.0	60-61	1.3
20	49	33	59-60	1.2
19	28	32.3	67	1.6
18	48	30.1	55-58	1.8
17	46	29.4	55-58	1.6
16	48	28.2	53-56	1.6
15	51	25.7	54-57	1.3
14	63	25.2	54-57	1.7
13	47	21.6	48-51	.9
12	47	21.6	48-51	1.0
11	48	19.6	48-50	1.0
10	49	19.1	48-50	.8
9	47	17.8	48-50	.6
8	48	16.8	49-50	.8
7	48	16.1	49-50	.7
6	49	16.1	49-50	.8
5a	49	14.9	49-50	.6
5	50	14.9	48-49	.7
4	50	14.8	48-49	.7
3	47	14.2	48	.7
2	37	15.1	36	.9
Ohio				
Emsworth	64	20.3	35-48	.6
Dashields	56	21.2	39-54	.6
Montgomery	49	22.2	37-39	.9
NewCumberland	26	26.4	104-125	-
Pike Island	17	32.5	100-115	-
Hannibal	13	35.0	110-132	-
Willow Island	13	36.0	107-130	-
Belleville	17	38.6	104-126	-
Racine	14	39.9	107-138	-
Gallipolis	48	37	58-64	3.4
Greenup	26	39.2	100-129	-
Meldahl	23	41.0	97-133	-
Markland	22	39.8	89-133	.6
McAlphine	24	44	82-116	.6
Cannelton	13	46.5	107-157	.6
Newburgh	10	50.9	104-128	.3
Uniontown	10	58.2	114-127	.5
Smithland	5	64.2	177-214	.1
52	57	74	3	1.4
53	56		3	-
Total				
Illinois				
LaGrange	46	31.3	46-49	.8
Peoria	46	28.3	44-52	1.5
Starved Rk	52	20.8	42-43	1.3
Marseilles	51	19.2	33-38	2.0
Dresden Road	52	14.5	33-38	.8
Brandon Road	52	14.5	33-38	3.1
Lockport	52	14.1	33-38	1.8
O'Brian	-	5.8	-	.1

Source: U.S. Army Engineer Institute for Water Resources.
Report on the Current Status of Selected U.S. Waterways, 1985

In 1984, the average delay per tow at Lock 26 was 8.9 hours, making it the most congested lock on the Upper Mississippi as well as the entire waterway. Average delays per tow at other locks were: 2.9 to 3.3 hours at Locks 22 to 25; 1.2 to 1.8 hours at Locks 14 to 21; and 0.6 to 1.0 hour at Locks 1 to 13.

Ohio River

Six of the 20 locks now exceed 45 years of age. Of the six, one at Gallipolis is being replaced while the other five (Emsworth, Montgomery, Dashields, Lock 52 and Lock 53) are receiving, or will shortly receive, major rehabilitations.

The Gallipolis Lock is currently the most congested lock on the Ohio River, incurring an average delay of 3.4 hours in 1984. This lock is considered a major constraint in the movement of coal to electric utilities and the steel industry. Other locks that incur delays are Lock 52 with an average delay of 1.4 hours per tow and the locks at Emsworth, Dashields, Montgomery, Markland, McAlphine and Cannelton with .6 to .9 hour per tow.

Illinois Waterway

Seven of the eight locks currently exceed 45 years in age. All of the old locks are being rehabilitated.

The delays experienced on the locks vary from a low of 0.8 hour at LaGrange and Dresden to a high of 3.1 hours at Brandon Road. According to the Corps, the delays at Brandon Road and Lockport are understated because of the "make-up" and "break-up" time involved in changing the tow size in these locations. Brandon Road and, to a smaller extent, Lockport constitute the major constraints on the Illinois.

3.4 Ports and Terminals

A wide variety of ports and terminals exist on the Mississippi system today. Some have long histories associated with the rivers and have grown into great cities because of their locations. These include Pittsburgh, at the

headwaters of the Ohio, Minneapolis/St. Paul, at the headwaters of the Mississippi, Omaha and Kansas City, on the Missouri; Chicago, on the Illinois; St. Louis and Memphis, on the main stem of the Mississippi, and Tulsa, Little Rock, and Pine Bluff, on the Arkansas.

According to the 1979 Mid-America Ports Study of the U.S. Maritime Administration, there are about 1,200 water terminals located in over 100 riverport areas along the Mississippi River and its tributaries, comprising close to 1,900 barge berthing facilities. These include 386 general cargo berths, 868 dry bulk cargo berths, and 640 liquid bulk cargo berths. About 70 percent of the terminals are single cargo facilities, 36 percent handled liquid bulks; 33 percent, dry bulks; 18 percent, grain; and 13 percent, general cargo. Storage facilities amount to 21 million square feet of covered storage for general cargo, over 147 million tons of covered and open storage for dry bulk cargos, 340 million barrels of tank storage for liquid bulk cargos, and more than 355 million bushels of elevator storage for grains. (A detailed but dated list of these facilities can be found in the Mid-America Ports Study prepared for the Maritime Administration, U.S. Department of Commerce in 1979.)

Terminal handling at ports vary according to type of cargos. Grains, for example, generally require covered storage unless direct loading from barge to ocean vessel is carried out. Unloading from barges is accomplished by use of pneumatic vacuum pipes, bucket elevators or grab buckets. These devices can be mounted on traveling towers or gantries and be used singly or in multiples. Belt conveyors are generally used for transfer along wharves and to storage. Some form of continuous handling system - continuous bucket or conveyor belt - is used by most grain unloading facilities. Loading is accomplished by belt conveyors which move the grain from storage to galleries on the wharf. From this point, grain is usually loaded into the vessels by spouts, some with mechanical trimmers. Loading spouts may be stationary or on traveling towers. With adjacent storage silos, the grain may be gravity loaded directly into the vessel by spouts without the need for wharf gallery conveyors. Most grain loading is accomplished by direct

conveyor belt system while a smaller portion is provided by gravity chute loading spout.

Another major commodity, coal, is generally loaded onto ship by bucket wheel or tunnel reclaimer from storage, belt conveyor transport to dockside, and either stationary, traveling or quadrant conveyor boom shiploaders. Barge unloading is accomplished by clamshell bucket and continuous bucket elevators. Belt conveyors transfer the coal to storage where it is stockpiled through use of a stacker supplemented by bulldozers and front-end loaders.

For liquid bulk cargos, such as petroleum, the predominant handling equipment is the barge pump and conventional cargo hose connected to onshore transfer system with a load/unload capability. Other types of cargos are handled somewhat differently by different equipment. For instance, containers are handled by specialized cranes designed for riverports such as Memphis, Tennesse, but this is not common since general cargo volume at most inland ports is very low.

As mentioned earlier, there is a diversity of inland ports and a discussion of each is not feasible. Three major ports will be discussed, namely, Minneapolis/St. Paul, which is at the head of navigation and a major grain shipping point; St. Louis on the Mississippi River, which handles a wide variety of commodities and serves as a major terminus for barge and rail traffic; and New Orleans at the mouth of the Mississippi River where it meets the Gulf of Mexico.

The Ports of Minneapolis and St. Paul

At the head of navigation are the Ports of Minneapolis and St. Paul, situated adjacent to each other on the Upper Mississippi. The two ports were established when immigrants began to move into the interior in the early 1800s. By the late 1800s, a boom in the lumber and logging industry which was also accompanied by the growth in railroads led to the rapid

development of the ports. Today, St. Paul and to a lesser extent, Minneapolis are busy river ports.

In recent years, the combined annual traffic was approximately 11 million tons, of which Minneapolis accounted for approximately 2.5 million tons while St. Paul accounted for 8.5 million tons. The single largest commodity is agricultural products, accounting for nearly 55 percent of total tonnage. This is followed by coal and petroleum products which account for about 27 and 9 percent of total annual traffic respectively. Also notable is the movement of potash from Saskatchewan, although the volume is relatively small. Agricultural products move through the ports in the outbound direction, that is down the Mississippi River to ports in the river mouth, such as New Orleans, for transfer onto ocean vessels; Saskatchewan potash also moves downbound the Mississippi to U.S. markets. On the other hand, coal and petroleum products are unloaded at Minneapolis and St. Paul to be transhipped to industries in the region. Since navigation on the Upper Mississippi is restricted to approximately eight months of the year, the ports are not navigable year-round.

The ports are served by several railroads, namely the Burlington Northern, Chicago Northwestern, and the Soo Line. In particular, the Burlington Northern and the Soo Line (owned by Canadian Pacific Ltd.) are connected to the Canadian National Railway (CNR) and the Canadian Pacific Railway (CPR) respectively, near Emerson, Manitoba. In turn, the CNR and CPR connects Emerson to Winnipeg, which is a major Canadian rail terminus. The distance between Winnipeg and Minneapolis/St. Paul by rail is about 450 miles.

Port of St. Louis

Located on the Upper Mississippi, downriver from its confluence with the Missouri and Illinois Rivers, the Port of St. Louis was founded in the mid-1700s to support a growing fur trade and an active grain trade. Today, St. Louis has more than 170 docks, piers and wharves. In recent years, commerce at the port amounted to approximately 23 million tons annually.

The major commodities are agricultural products, coal and petroleum products, with each accounting between 6 to 7 million annually.

St. Louis is served by major railroads, some of which are the Burlington Northern, Chessie, Chicago Northwestern, Conrail, Illinois central Gulf, Missouri-Kansas-Texas, Norfolk Southern, Southern Pacific Rail, and Union Pacific. Due to the good rail access, the port is a major transhipment point for barge and rail traffic. The port is also opened year-round, since navigation is not constrained by winter conditions. In this regard, a notable point is that potash from Saskatchewan is shipped into the port by the Burlington Northern during the winter months to be transhipped onto barges for the downbound journey on the Mississippi River.

Port of New Orleans

The Port of New Orleans is located strategically at the meeting of the Mississippi River and the Gulf of Mexico. Founded as a French outpost during the colonial period, New Orleans is now one of the gateways to the mid-continent of the U.S. A deepwater port with a navigable depth of 40 feet, New Orleans is a major transhipment point for barge and ocean vessel traffic. The port has more than 320 piers, docks and wharves.

In recent years, the annual traffic amounted to approximately 180 million tons, with agricultural products, coal and petroleum products accounting for 83, 13 and, 53 million tons respectively. Agricultural products (i.e., grains) and coal, which originate hundreds of miles upstream on the Mississippi River and its tributaries, are barged to New Orleans and other terminals in the Lower Mississippi, such as Baton Rouge, for transhipment to overseas markets. In addition to being served by barges, port terminals in New Orleans are also connected to railroads such as Illinois Central Gulf (sold to Chicago, Missouri and Western in 1986), Chessie, Norfolk Southern, Southern Pacific Rail and Union Pacific. The port is expected to handle increasing levels of traffic in future and the merits of deepening the existing 40-foot channel to accommodate larger ocean vessels are currently being debated.

3.5 Institutional Arrangements

The U.S. Army Corps of Engineers plays an important role in developing inland waterways. Under authorization from Congress, the Corps maintains and improves the navigable channels of the waterway to ensure safe and unimpeded navigation. While this involves engineering works, the Corps also undertakes studies to ascertain the future use of the waterway and the investment that would be required. By way of indicating the Corps' involvement, Exhibit 3.6 shows the construction and operating and maintenance expenditures for all inland waterways, including the Mississippi which is the main system, from 1977 to 1984 in 1984 dollars. Construction expenditures for inland waterways over the period ranged between $314 to $655 million while operating and maintenance expenditures fluctuated between $304 to $374 million. In general, operating and maintenance expenditures accounted for about 40 percent of total navigation expenditures.

The waterway's infrastructure also includes port and terminals, which act as storage and transfer points for cargos in transit. The jurisdictional responsibilities lie not with the Corps or other federal agency, but primarily with the individual states. Port authorities are created by the states and they are charged with the responsibility for the management and planning of port facilities. There are also private terminal facilities, owned and operated by major users of the waterway such as companies in the chemical and oil industries. Thus, port and terminal developments are confined to state and private interests.

The waterway is also influenced by federal government programs which affect the private costs of the towboat and barge industry. There are three types of programs involved, and they can be classified as cost-recovery, financing and tax benefits. Of the three programs, the two involving financing and tax benefits are considered as maritime incentives while the one on cost-recovery is a tax on industry for the use of government provided navigation facilities.

Exhibit 3.6

U.S. Army Corps of Engineers Expenditures for Shallow Draft Navigation

(1984 $ 000)

	Operating & Maintenance	Construction
1977	$374,424	$461,000
1978	352,519	545,875
1979	351,455	527,998
1980	333,301	565,688
1981	308,566	655,039
1982	336,996	619,257
1983	304,000	359,000
1984	328,000	314,000

Source: U.S. Army Corps of Engineers

In the case of cost-recovery, the U.S. government has historically chosen not to charge water carriers for the use of navigation facilities. However, the need to finance waterway expenditures by charging users led to the passage of Public Law 95-502 in 1978 which established the Inland Waterways Trust Fund. Inland river carriers were subjected to fuel tax on October, 1980 of four cents per gallon. The fuel tax has since risen incrementally to 10 cents per gallon in October, 1985 and will eventually rise to 20 cents a gallon by 1996. Prior to the tax increase in October, 1985, when the tax rate was then at eight cents per gallon, the fuel taxes that were collected annually amounted to $50 million. At the same time the accumulated total in the Inland Waterways Trust Fund stood at approximately $230 million. Compared to the annual navigation expenditures incurred on the waterway, the fuel tax of $50 million is considerably short of the $300 million in annual operating and maintenance expenses or the $300 to $600 million in annual construction expenditures.

The financing program provided under U.S. law is contained in Title XI of the Merchant Marine Act of 1936. The Act established the Federal Ship Financing Guarantees Program which initially provided only for loan insurance. With amendments to the Act in 1972, direct government guarantees were established. Guarantees are available to American buyers and operators of United States built vessels for up to 87 1/2 percent of the actual cost of new vessels. The amount and terms of the guarantee vary by the type of vessel, the amount of foreign components incorporated into a vessel, and the financial condition of the applicant.

Title XI essentially reduces the cost of commercial financing for newbuilding projects. It is estimated that without Title XI support, owners would have to pay two to four percent more on commercial loans, and repayment periods would be reduced from 20 - 25 years to about 8 - 10 years. In fiscal year 1981, the annual ceiling limited the amount of new guarantees which could be issued to $1.2 billion. More recently, the annual guarantee limit was fixed at $850 million. It is reported that, to date, Title XI guarantees in force and commitments outstanding amounts to about $6.8 billion.

The tax benefit program that applies to the waterway is the Construction Reserve Fund (CRF). Authorized by Section 511 of the Merchant Marine Act, 1936, as amended, CRF is a financial assistance program which provides tax deferral benefits to United States shipowners. Through the CRF, shipowners operating vessels in the foreign or domestic commerce of the United States can defer the gain attributable to the sale or loss of a vessel. The proceeds deposited must be used to construct, reconstruct, or acquire vessels of United States registry built in the United States. The ability to defer gain on certain transactions through deposits to the CRF applies only to vessel owners. Citizens operating a vessel owned by another party cannot benefit from the provisions relating to the non-recognition of gain from the sale or less of a vessel.

Section 511 also permits a vessel's owner or operator to deposit into the CRF earnings from the operation of United States registry vessels and earnings from the investment of the fund. Such deposits do not exempt the taxpayer from tax liability on the earnings. However, earnings so deposited are considered to have been accumulated for the reasonable needs of business and are not subject to accumulated earnings tax. This ability to accumulate funds for the construction, reconstruction, or acquisition of a vessel is the only benefit available through the CRF to a non-owner operator of a vessel. The program is intended to encourage shipowners operating vessels in foreign and domestic commerce to upgrade their fleets and, to date, only $6.6 million have been deposited into CRF.

Finally, the waterway today is by and large free of economic regulation. Economic regulation was, however, enforced earlier by Congress through the Transportation Act of 1940. Authority was given to the Interstate Commerce Commission to regulate rates and entry into the industry. However, bulk commodities were exempted from regulation. Regulated commerce consists primarily of iron and steel products. This has had the practical effect of applying regulation to a small part of the industry. For several years the law subjected bulk commodities to regulation under either of two conditions. These were the mixing of

regulated and unregulated commodities in the same tow and three or more unregulated commodities in the same tow. These provisions were not effectively enforced, and were subsequently removed from law.

4. Traffic on the Mississippi River System

The significance of the Mississippi River System is illustrated by the amount and type of traffic moved on the system. This section reviews traffic on the river in terms of commodity tonnages, trading patterns, and barge movements to provide some understanding of the use of the waterway and the industries it serves.

4.1 Commodity Flows

The annual tonnages for domestic traffic (i.e., excluding international traffic by ocean going vessels) on the Mississippi River System (i.e., main channels and all tributaries of the Mississippi, Illinois, Missouri and Ohio Rivers) over the period 1976 to 1983 are shown in Exhibit 4.1. During this period, traffic grew by 18 percent from 297 million tons in 1974 to 350 million tons in 1983. A peak of 371 million tons was reached in 1979 but thereafter tonnages declined. The short term decline appeared to have reached a bottom in 1982 at 347 million tons and by 1983 the annual tonnage started to move up to 350 million tons. More recent statistics are not available, but it appears that the declining trend has begun to reverse itself.

The commodity structure of the traffic during the period was principally made up of coal, agricultural products (mainly grains), crude oil petroleum products, and construction materials. Statistics on the composition of traffic are shown in Exhibit 4.2, and it is interesting to note the changing significance of individual commodities over the period. In 1970, when the total traffic was 297.3 million tons, coal accounted for 34 percent of this total, followed by petroleum products with 16 percent, construction materials with 14 percent, crude oil with nine percent and agricultural products with eight percent. By 1983, the total traffic had risen to 350 million tons, and coal retained its position with 34 percent of total traffic followed by agricultural products with 21 percent, petroleum products with 14 percent, construction materials with 10 percent, and chemicals with five percent. The rise in agricultural products is clearly the most significant development, and has in fact been largely responsible, in

Exhibit 4.1

Mississippi River System
Annual Traffic

Year	Tons (millions)
1970	297.3
1971	303.2
1972	326.6
1973	317.6
1974	330.1
1975	330.1
1976	345.5
1977	352.5
1978	355.4
1979	370.8
1980	365.7
1981	362.9
1982	347.5
1983	350.4

Source: U.S. Army Corps of Engineers, Waterborne Commerce of the United States, Part 2

Exhibit 4.2

Mississippi River System
Traffic Composition
(million tons)

Year	Major Agricultural Products	Coal	Crude Oil	Petroleum Products	Construction Materials	Major Fertilizers	Chemicals and Aromatics	All Other Commodities
1970	23.9	102.0	25.8	47.5	40.5	3.9	15.0	42.2
1971	23.9	96.7	26.2	51.5	13.4	44.5	4.5	15.6
1972	30.9	108.7	29.3	52.2	14.6	41.9	6.5	16.3
1973	32.2	104.1	25.1	53.1	16.0	42.5	5.9	15.0
1974	35.6	106.4	19.1	53.4	17.1	43.4	6.5	16.9
1975	39.4	115.7	21.6	54.9	18.7	38.5	6.2	14.8
1976	44.8	116.4	21.1	60.8	22.3	38.2	6.0	15.2
1977	46.7	117.6	18.8	65.3	24.4	40.5	7.0	16.3
1978	51.9	106.0	20.5	65.8	28.1	44.6	7.1	17.1
1979	54.8	121.4	17.6	62.8	27.0	46.3	7.6	19.1
1980	64.3	123.0	15.0	59.8	23.9	37.4	8.4	18.7
1981	66.3	130.6	13.8	55.7	21.8	33.4	7.3	17.8
1982	73.8	121.2	14.0	52.1	20.5	32.0	6.5	15.5
1983	73.1	118.9	13.2	48.6	17.4	36.3	6.3	17.0

Source: U.S. Army Corps of Engineers,
Waterborne Commerce of the United States, Part 2

conjunction with coal, for the increase in total tonnage since 1970. Over this period, agricultural products increased threefold, from 24 million tons to 73 million tons in response to export demand, while coal increased by 17 percent from 102 million tons to 119 million tons due to increased requirements by domestic electric utilities and the steel industry. In parallel with the rise in agricultural products is the increase in tonnage of fertilizers.

4.2 Trade Patterns

Understanding the trade patterns of the principal commodities provides an important perspective of the way the waterway is being used. This is discussed below for the principal movements.

Agricultural Products - Grains

Originating at the farms in the midwest, grains (including soybeans) are transported by rail and truck to grain terminals on the Mississippi River System, notably Minneapolis/St. Paul and St. Louis, for the downbound journey to Gulf ports for export overseas. The proximity of the waterway to the corn, soybean, and wheat producing areas are shown in Exhibits 4.3 to 4.5. Furthermore, Exhibit 4.6 shows the major trade patterns by river segment. It is seen from this exhibit that corn and soybean move downbound from the upper reaches of the Mississippi River System to the Gulf, while wheat and other grains move downbound from more dispersed origins. Due to the long distances that grains move on the system, the commodity has the highest ton-miles on the waterway and constitutes the most important commodity for the towboat and barge industry.

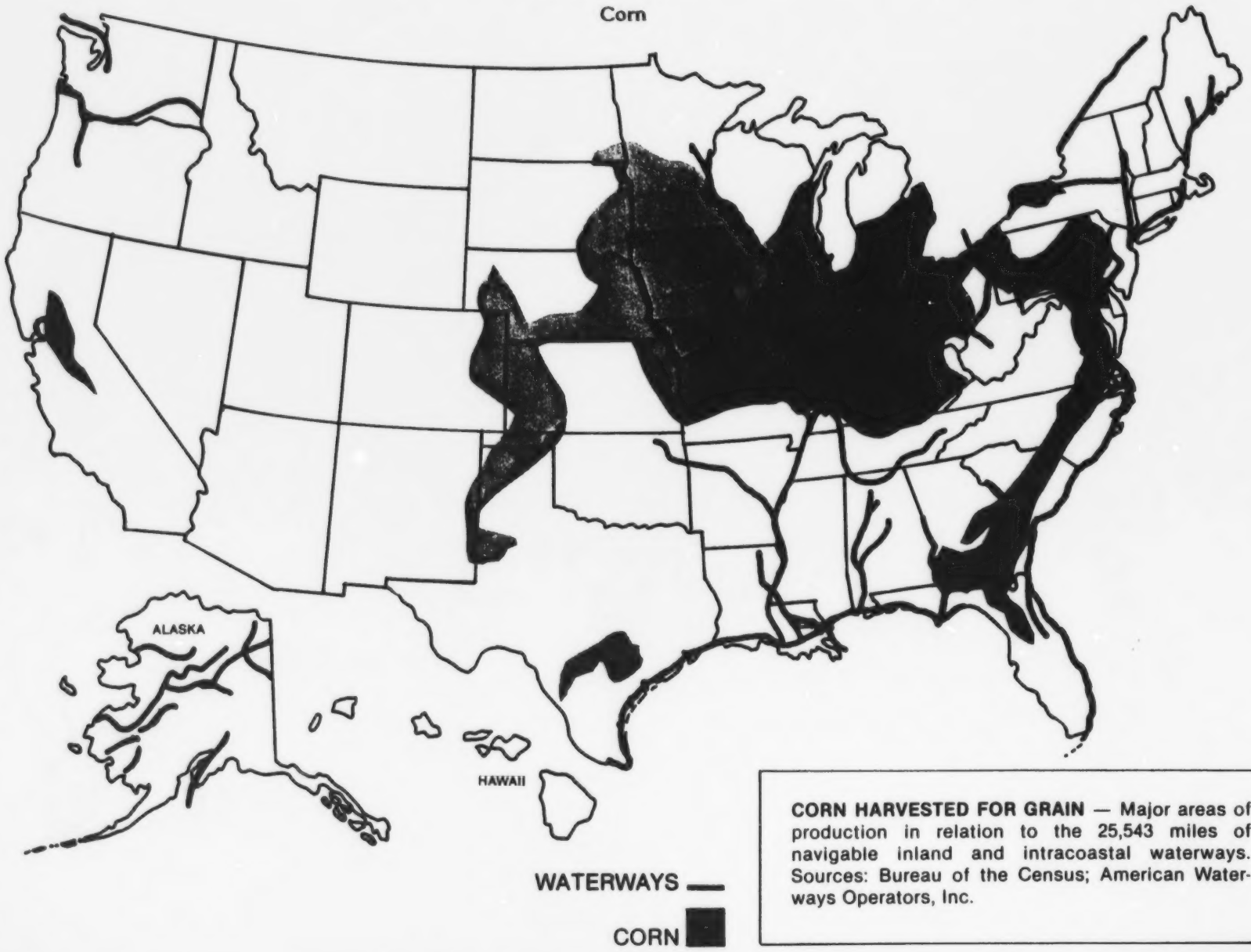
Coal

The coal mines of the Appalachians are the principal sources of coal on the waterway. Exhibit 4.7 shows the coal producing areas in relation to the waterway, and it is seen that the Ohio River System is the main waterway that serves this industry. Consumers of coal are primarily the utility and steel industries in the region. Coal is also exported overseas via the waterway, but the tonnage is relatively small in spite of optimistic

Exhibit 4.3

Inland Waterways

Corn



CORN HARVESTED FOR GRAIN — Major areas of production in relation to the 25,543 miles of navigable inland and intracoastal waterways. Sources: Bureau of the Census; American Waterways Operators, Inc.

Exhibit 4.4

Inland Waterways

Soybean

SOYBEANS HARVESTED FOR BEANS — Major areas of production in relation to the 25,543 miles of navigable inland and intracoastal waterways. Sources: Bureau of the Census; American Waterways Operators, Inc.

Exhibit 4.5

Inland Waterways

Wheat

WHEAT HARVESTED — Major areas of production in relation to the 25,543 miles of navigable inland and intracoastal waterways. Sources: Bureau of the Census; American Waterways Operators, Inc.

Exhibit 4.6

Major Trade Patterns of Mississippi Grain

(million tons)

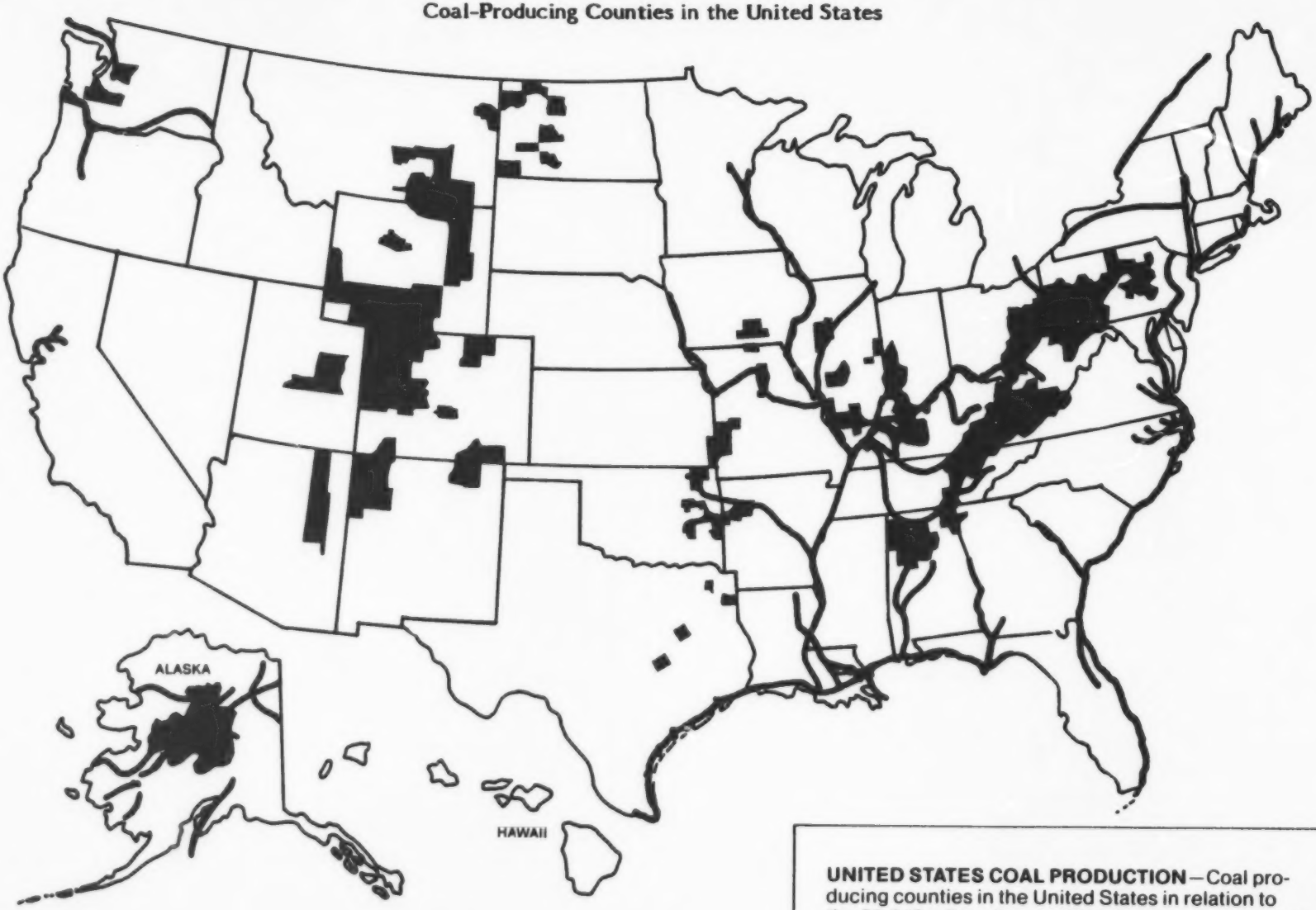
From	To	1970 Corn	1970 Soybean	1970 Wheat	1970 Other Grains	1970 Total	1981 Corn	1981 Soybean	1981 Wheat	1981 Other Grains	1981 Total
Upper Mississippi River	Baton Rouge and Gulf	3.3	1.8	.3	-	5.4	14.7	3.4	1.8	-	19.9
Lower Upper Mississippi River	"	.1	.2			.3	.8	.7	.5	.8	2.8
Lower Mississippi River	"	-	-	.2	-	1.7	-	2.0	2.8	-	4.8
Illinois Waterway	"	4.2	1.2	-	-	5.4	11.2	2.8	-	-	14.0
Ohio River System	"	.1	.1			.2	1.5	1.2	.5	.1	3.3
All Other	All Others	3.4	3.1	2.0	0.5	9.0	4.4	4.7	4.9	1.7	14.7
		11.1	7.9	2.5	0.5	22.0	32.6	14.8	10.5	1.6	59.6

Source: U.S. Army Corps of Engineers,
Waterborne Commerce of the United States, Part 5

Exhibit 4.7

Inland Waterways

Coal-Producing Counties in the United States



UNITED STATES COAL PRODUCTION—Coal producing counties in the United States in relation to the 25,543 miles of navigable inland and intracoastal waterways. Sources: Department of Energy; American Waterways Operators, Inc.

Exhibit 4.8

Major Coal Trading Patterns on the Mississippi River System

(million tons)

From	To	1970	1981
Upper Mississippi River	Upper Mississippi	-	1.4
Lower Upper Mississippi River	Lower Mississippi River	.1	6.1
	Upper Mississippi River	2.8	2.3
	Ohio River System	-	2.0
Illinois Waterway	Illinois Waterway	4.9	4.4
Ohio River System	Ohio River System	65.9	80.4
	Baton Rouge and Gulf	3.5	6.5
All Others	All Others	24.8	27.5
Total		102.0	130.6

Source: U.S. Army Corps of Engineers.
Waterborne Commerce of the United States, Part 5.

expectations during the late seventies. The pattern of coal movement is shown in Exhibit 4.8 and, as can be seen, the major movements are within the Ohio River System, where coal producers and consumers, such as utilities of the Tennessee Valley Authority and steel mills, are situated. Other coal movements are relatively minor and this includes export movements which originate from the Ohio River System and destined for ports in Baton Rouge and the Gulf.

Other Principal Commodities

In this category, commodities such as petroleum products, crude oil, construction materials, and fertilizers and chemicals are included. In the case of petroleum products and crude oil, the major movement is upbound the Mississippi from refineries on the Gulf to industrial centres on the Ohio River. The remaining commodities are more dispersed in their movements and they exhibit a less discernible trend in trading patterns.

The trading patterns discussed above can also be illustrated by the average length of haul. Due to the interaction in trade between the Mississippi system and the Gulf Intracoastal system, statistics are generally provided together. This is shown in Exhibit 4.9, and it is seen that agricultural produce (grains) have the longest hauling distance, followed by chemicals and fertilizers, other commodities, coal, crude oil and petroleum products, and construction materials.

4.3 Towboat and Barge Traffic

As indicated previously, the configuration of tows varies significantly with the river segment. For example, small rivers, such as the Monongahela and the Allegheny on the Ohio River system, will have tows made up of only one to four barges. The Lower Mississippi, on the other hand, may have huge tows with 40 or more barges. The average tow size is considered to be eight barges, although in practice the tow configuration varies greatly according to circumstances.

Exhibit 4.9

Mississippi River System and Gulf Intracoastal Waterway

(Average Haul in Miles)

Year	Major Agriculture Products	Coal and Coke	Crude Oil & Petroleum Products	Construction and Waterway Improvement Materials	Chemicals and Fertilizer	All Other Commodities
1970	1,093	254	286	69	704	514
1971	1,070	264	300	72	712	539
1972	1,121	282	286	73	670	520
1973	1,200	269	276	72	658	487
1974	1,179	280	292	76	695	515
1975	1,130	288	278	71	721	511
1976	1,113	276	279	83	719	532
1977	1,121	296	282	92	733	540
1978	1,104	301	279	109	729	578
1979	1,128	331	274	121	723	567
1980	1,119	353	269	124	721	610
1981	1,080	413	257	109	720	573
1982	1,058	374	248	106	705	591
1983 (Estimate)	1,100	350	260	110	720	580

Source: U.S. Army Corps of Engineers.
Waterborne Commerce of the United States, Part 5.

Exhibit 4.10

Mississippi River System
Barge Traffic Movements

(Number of Barges)

River Section	1970				1975				1981			
	Upbound		Downbound		Upbound		Downbound		Upbound		Downbound	
	Dry Barge	Tank Barge	Dry Barge	Tank Barge	Dry Barge	Tank Barge	Dry Barge	Tank Barge	Dry Barge	Tank Barge	Dry Barge	Tank Barge
Upper Mississippi River	24,929	7,372	24,925	7,370	30,941	6,831	30,834	6,916	38,628	5,427	38,582	5,353
Lower Upper Mississippi River	27,116	7,009	27,111	7,006	34,714	6,666	35,297	6,677	48,341	5,430	48,383	5,287
Lower Mississippi River	41,176	13,483	41,150	13,472	47,914	14,270	48,521	13,970	73,926	11,910	73,415	11,633
Missouri River	22,672	418	22,660	406	15,357	308	15,282	306	10,420	330	11,075	235
Ohio River	95,901	16,228	95,894	16,230	93,316	14,236	93,292	14,164	114,150	11,677	111,081	11,578
Tennessee River	19,928	2,131	19,920	2,130	20,319	2,142	20,233	2,082	19,603	1,548	19,736	1,519
McClellan-Kerr Arkansas River	7,524	52	7,524	48	8,544	301	8,590	259	7,988	742	7,816	781

Note: Movements include empty and loaded barges.

Source: U.S. Army Corps of Engineers, Waterborne Commerce of the United States, Part 2

Barge traffic on the river system is shown in Exhibit 4.10 for dry barge (i.e., for carrying dry-bulk commodities) and tank barge (i.e., for carrying liquid bulk commodities) movements. For the period shown, the Ohio River has the heaviest traffic on the waterway, followed by various sections of the Mississippi River. In every part of the river system, dry barge traffic exceeds tank barge traffic. Although downbound traffic is approximately balanced by upbound traffic, the cargo flow patterns are quite different. The downbound movement is dominated by barges loaded with drybulk commodities while the upbound movement is dominated by empty dry barges. Also, the downbound movement consists of empty tank barges while the upbound movement consists of loaded tank barges carrying crude oil, petroleum products and chemicals.

5. The Mississippi Towboat and Barge Industry

The towboat and barge industry plays a pivotal role in enhancing trade and transportation on the Mississippi River System. Due to its technological features and economics, the towboat and barge concept has evolved to be a highly competitive mode of transport. This section reviews the particular characteristics of the industry and the condition that it is in today.

5.1 Industry Structure

In the past, the towboat and barge industry on the Mississippi attracted many corporate owners and investors. Some of these owners have expanded their businesses to include fleet operating and management services, bulk and general cargo terminal operations, and shipyards for new construction and repair of vessels. In the process, these owners have become common carriers, serving shippers in the region according to agreed rates and schedules. Other owners attracted to the industry include major shippers on the waterway, such as grain companies, coal producers, utilities, agricultural cooperatives and chemical companies; that is, private carriers serving their own transportation needs. More recently, outside investors have financed new barges and set up management companies to operate the fleet on a for-hire basis; these are known as independent operators.

Today, there are approximately 1,500 carriers on the waterway operating some 24,000 dry barges, 4,000 tank barges and 3,000 towboats. Although the industry consists of many operators, there are about 20 companies that are considered to have a visible presence on the waterway. These companies are shown in Exhibit 5.1, where their importance are indicated by the amount of revenues earned and number of workers employed. The two largest companies are American Commercial Barge Line, Inc. and Midland Enterprises, Inc. with 1982 annual revenues of $441 million and $151 million respectively. The next seven largest companies are smaller, with annual revenues ranging from $52 million to $67 million.

Exhibit 5.1

Barge Lines 1982 Revenues and Employee Count

Parent Company	Company	$ Revenue (millions)	Employees
TGT	American Commercial Barge	411	1,200
EGFA	Midland	151	1,400
Dravo	Dravo Mechling	67	600
CLC	Wisconsin Barge Line	67	600
TCB	Twin City Barge	60	400
Kirby	Dixie Carriers	59	400
HNG	Federal Barge Line	59	500
Agri-Trans	Agri-Trans	57	400
Chromalloy	Valley Line	52	800
Crounse	Crounse	36	400
U.S. Steel	Ohio Barge Line	36	400
	Consolidated Grain & Barge	26	700
	Sioux City New Orleans	26	200
Nicor	National Marine Service	26	400
U.S. Steel	Warrior & Gulf Navigation	21	700
	Houston Barge Lines Inc.	14	300
Hines	Hines Inc.	10	100
Igert	Igert	10	100
Igram	Ingram	10	100
Exxon	Exxon Inland	8	300
	Walker Towing	7	100
	Choctaw Towing	5	100
	Gladders	5	100
	Chemical Towing	4	100
	Waxler Towing	4	100

Source: Temple, Barker & Sloane, Inc. A Guide to Strategic Planning for the Inland Barge and Towing Industry - Final Report. Prepared for Maritime Administration, U.S. Department of Transportation, December 1984.

Exhibit 5.2

Major Covered Hopper Barge Fleets 1982*

ıre (Private and for Hire)				Major Common Carriers				Independents			
	Qty	Tons Capacity (000)	Average Yr. Built		Qty	Tons Capacity (000)	Average Yr. Built		Qty	Tons Capacity (000)	Average Yr. Built
	458	678	70	ACBL	753	1,106	72	Alter	141	210	75
	577	846	75	Valley	1,226	1,811	72	Arrow	122	177	71
	414	605	68	Dravo-Mechling	608	889	70	Gladders	198	295	80
ers	292	430	72	Federal	695	1,038	72	ML Barge	249	375	79
	328	489	75	ORCO	127	182	71	MEMCO	368	546	77
d	738	1,092	76	Riverway	458	675	69	Mid-America	122	177	64
s	382	558	78	SCNO	403	601	71	Port City	151	238	77
	176	262	74					River Line	97	139	78
	211	314	77					ICB	203	294	74
								Waterway	174	152	81
								Wisconsin	569	848	72
	3,576	5,274	74	Subtotal	4,270	6,302	71	Subtotal	2,394	3,531	76
arge Sizes	1,475 tons			Average Barge Size: 1,475 tons				Average Barge Size: 1,475 tons			

otal Major Fleets = 10,240 barges
15,107,000 short tone capacity
1973 average year built

34.9% agricultural (private and for hire)
41.7% major common carriers (and subsidiaries)
23.4% independents
100.0%

nore than 100 barges.

nple, Barker & Sloane, Inc. A Guide to Strategic Planning for the Inland Barge and Towing Industry - Final Report. pared for Maritime Administration, U.S. Department of Transportation, December 1984.

Exhibit 5.3

Major Open Hopper Barge Fleets 1982*

Coal Producers			Utilities			Steel Companies			Major Common Carriers			Independents		
No.	Tons Capacity (000)	Average Yr. Built	No.	Tons Capacity (000)	Average Yr Built	No.	Tons Capacity (000)	Average Yr. Built	No.	Tons Capacity (000)	Average Yr. Built	No.	Tons Capacity (000)	Average Yr. Built
309	309	68	AEP/I&M	764	1,017	74	U.S. Steel	1,259	1,149	72	ACBL	886	1,673	74	Campbell	94	100	64
			Mid South	221	315	66					Alter	141	216	74	Canal	146	214	78
											Dravo-Mechling	137	189	64	CentralGulf	113	339	82
											ORCO	1,312	1,871	72	Crain Bros.	103	103	51
											Valley	154	221	60	Crounee	481	685	73
															Haney	103	116	69
															Harcon	106	155	78
															Ingram	162	241	80
															M/G	330	479	74
															McDonough	183	213	61
															Mon River	401	421	60
309	309	68		985	1,332	72		1,259	1,149	72		2,630	4,170	72		2,222	3,066	70
e Size 1,000 tons			Average Barge Size 1,352 tons				Average Barge Size: 936 tons				Average Barge Size: 1,586 tons				Average Barge Size: 1,408 tons			

al Major Fleets = 7,405 barges
10,026,000 short tons capacity
1972 average year built

3.1% coal producers
13.3% utilities
13.6% steel companies
41.6% common carriers
28.4% independents

re than 100 barges.

le, Barker & Sloane, Inc. A Guide to Strategic Planning for the Inland Barge and Towing Industry
al Report. Prepared for Maritime Administration, U.S. Department of Transportation, December 1984.

Another way of looking at industry structure is the ownership of large fleets. Exhibits 5.2 and 5.3 show the companies that own a fleet of 100 barges or more, for either the covered hopper type or open hopper type. As shown in Exhibit 5.2, the covered hopper barge fleets are owned primarily by common carriers (35%), private carriers (42%) in the agricultural industry and independent operators (23%). A practice of industry is the conversion of old covered hopper barges to open hopper barges but not vice versa. The open hopper barge fleets shown in Exhibit 5.3 are owned primarily by common carriers (42%), followed by private carriers belonging to the coal, utility and steel industries (3.1%, 13.3% and 13.6% respectively), and independents (28.4%). As indicated by the ownership characteristics, open barges are used primarily in the coal trade. As for the tank barge fleet, no comparable data have been found, but it is believed that common carriers and companies in the petroleum and chemical industries, such as Exxon, Dow Chemical and Union Carbide, are the major owners.

5.2 Financial Performance

The financial performance of industry in recent years can be measured by a variety of financial ratios. In this discussion the current ratio, operating margin and return on capital will be employed. Generally there is little financial information that is publicly available on barge companies. This is largely because many barge lines are privately held and they do not disclose annual reports. There is, however, one useful source which is the annual study of the financial statements of 50 to 70 barge companies performed by Robert Morris Associates. The discussion below is based on the Morris study.

The current ratio (i.e., current assets divided by current liabilities) indicates the adequacy of working capital in industry, and it is generally regarded that an acceptable level of safety requires that for $1 of current liabilities there should be $2 in current assets. According to the Morris study (see Exhibit 5.4), the current ratio estimated for 1979 and 1983 were .99 and .91 respectively. On this basis, the current ratio for both

Exhibit 5.4

Inland Barge Industry Financial Performance

(percent)

	1979	1980	1981	1982	1983
Assets					
Cash	6.9	9.6	7.8	7.5	6.2
Accounts and Notes Receivable	18.0	15.4	19.1	16.0	11.5
Inventory	2.6	4.5	3.9	4.6	2.5
All Other Current	3.4	1.9	2.3	2.2	1.0
Total Current	31.0	31.5	33.0	30.3	21.2
Fixed Assets (net)	58.5	54.5	55.6	61.6	67.1
Intangibles (net)	0.2	1.4	0.4	0.5	0.6
All Other Non-Current	10.3	12.7	11.0	7.6	11.0
Total Non-Current	69.0	68.5	67.0	69.7	78.8
Total Current and Non-Current	100.0	100.0	100.0	100.0	100.0
Liabilities					
Notes Payable--Short Term	3.9	6.2	5.9	7.4	6.0
Current Maturities-Long Term Debt	7.1	5.0	5.7	9.8	4.6
Accounts and Notes Payable	12.3	9.2	13.5	9.8	6.2
Accrued Expenses	3.0	3.8	2.8	3.3	2.6
All Other Current	4.9	7.1	7.3	5.0	3.8
Total Current	31.2	31.4	35.2	31.3	23.3
Long-Term Debt	36.2	32.5	35.0	37.5	40.3
All Other Non-Current	2.7	4.9	2.6	4.6	5.5
Net Worth	29.9	31.2	27.2	26.6	30.9
Total	100.0	100.0	100.0	100.0	100.0
Income Data					
Net Sales	100.0	100.0	100.0	100.0	100.0
Operating Expenses	82.8	80.9	85.2	89.2	87.7
Operating Profit	17.2	19.1	14.8	10.8	12.3
All Other Expenses	4.5	4.8	6.0	7.6	9.4
Profit Before Taxes	12.7	14.3	8.8	3.2	2.9

years have not met the required safety level and in fact has deteriorated over the period. This indicates that industry may not have a comfortable amount of working capital to meet its obligations or to take advantage of opportunities in the short term.

Industry's operating profit, which is shown in Exhibit 5.4, has also deteriorated in recent years. In 1979 it accounted for 17.2 percent of net sales, but in 1983 it had dropped to 12.3 percent. During this period operating expenses increased visibly from 82.8 to 87.7 percent, thus affecting the performance of industry. Also, profit before taxes deteriorated over the same period from 12.7 to 2.9 percent.

Finally, the study by Morris shows that the return on assets in 1976 was 3.5 percent while in 1981 (the latest year given) it was 3.4 percent. In the intervening years, the statistics fluctuated between 2.4 and 4.6 percent. According to Moody's Transportation Manual, the return on assets of Class I railroads during the same period increased from 0.3% to 4.5%, while the American Trucking Association's report on Financial Analysis of the Motor Carrier Industry indicates a return of 2.0% to 7.4% for trucks. The barge lines rate of return compare favourably with railroads but less favourably with motor carriers.

In reviewing these statistics, it must be noted that financial data for recent years were not available, particularly for 1984 and 1985. It is envisaged, however, that due to the continuing poor market conditions, the financial health of the towboat and barge industry has deteriorated further still.

5.3 Towboat and Barge Fleet

The tug and barge fleet on the Mississippi River System and the Gulf Intracoastal Waterway for the period 1970 to 1982 is shown in Exhibit 5.5. The exhibit shows a significant growth in virtually all categories of vessels. Not only have the fleets for towboats, dry barges and tank barges increased substantially over the period, the capacity per vessel has also increased at

Exhibit 5.5

Towboat and Barge Fleet for Mississippi River System and Gulf Intracoastal Waterway

	Towboats			Dry Cargo Barges			Tank Barges		
Year	Number of Vessels	Total Horsepower	Average Horsepower	Number of Vessels	Total Capacity (short tons)	Average Capacity (short tons)	Number of Vessels	Total Capacity (short tons)	Average Capacity (short tons)
1970	2,344	2,305,305	983	13,318	14,863,812	1,116	2,581	4,753,480	1,842
1971	2,427	2,548,578	1,050	13,985	15,934,718	1,139	2,788	5,591,111	2,005
1972	2,293	2,654,112	1,157	14,904	17,293,167	1,160	2,697	5,841,980	2,166
1973	2,332	2,848,674	1,222	15,765	18,583,511	1,178	2,751	5,653,353	2,055
1974	2,404	3,226,545	1,342	17,345	21,031,652	1,212	2,903	6,117,768	2,107
1975	2,541	3,574,850	1,407	18,049	22,255,050	1,233	2,979	6,295,236	2,113
1976	2,578	3,739,951	1,451	18,709	23,270,565	1,244	3,042	6,646,957	2,185
1977	2,614	3,905,052	1,494	19,368	24,286,079	1,254	3,105	6,998,678	2,254
1978	2,632	4,072,634	1,547	19,809	25,149,335	1,270	3,250	6,717,435	2,067
1979	2,722	4,224,297	1,552	21,042	27,110,036	1,288	3,332	6,884,322	2,066
1980	2,945	4,637,667	1,575	22,586	29,261,091	1,295	3,445	7,147,532	2,074
1981	3,107	4,901,527	1,578	24,000	31,800,000	1,325	3,950	8,100,000	2,050
1982	3,161	4,989,480	1,578	24,331	32,590,978	1,339	4,183	8,557,207	2,046
1970-82	35%	116%	61%	83%	119%	20%	62%	80%	11%

Source: U.S. Army Corps of Engineers, Water Resources Support Center, Waterborne Commerce Statistics Center. "Summary of the United States Flag Passenger and Cargo Vessels Operating or Available for Operation"

the same time. For instance, the average horsepower of towboats increased by 61 percent (983 to 1578 hp.) while the average capacity of dry barges and tank barges increased by 20 percent (1116 to 1339 tons) and 11 percent (1842 to 2046 tons) respectively.

A breakdown of the existing fleet and their respective ages are also shown in Exhibit 5.6. Note that the towboat fleet includes only towboats for line haul purposes, that is, towboats of less than 1000 horsepower are excluded. The age distribution shows that there is a higher proportion of tank barges, open hopper barges and towboats of 1000 - 4000 horsepower which are more than 20 years old than compared to covered hopper barges and towboats greater than 4000 horsepower. This means that the fleets for covered hopper barges and towboats greater than 4000 horsepower are relatively young, indicating recent additions to the fleet. Barge operators assume a 20-year economic life for their equipment although the physical life can be as long as 30 to 40 years depending on the manner the equipment is used and maintained.

Since 1970, most of the additions to the fleet took place during two identifiable periods: 1971 to 1974 and 1979 to 1981. In the period 1971 to 1974, the increase in fleet size was in response to strong demand and, according to the Temple, Barker and Sloane Inc. study entitled A Guide to Strategic Planning for the Inland Barge and Towing Industry prepared for the Maritime Administration, the high utilization rate of almost 100 percent achieved during 1970 to 1972 was a sign of long term demand that led to significant investments in the fleet. However, the circumstances were quite different in the period 1979 to 1981, as major investments in the fleet were made in response to temporary market developments. In particular, these investments were triggered by the short term rising trend in rates and the expectation of large volumes of coal and grain to be exported. None of these events materialized by the time the vessels were delivered. Many of these investments were made by outside investors and it has been alleged that the Title XI loan guarantee program, with its easy financing arrangements, has encouraged these investments to be made. As a result,

Exhibit 5.6

Equipment Type and Age Profile in 1984

Equipment Type	Vessels Over 20 Years	Vessels in Fleet	Percent Over 20 Years
Open hopper	1,726	7,773	22%
Covered hopper	1,262	11,444	11
Tank	455	1,733	26
1,000 - 3,000 HP towboat	92	380	24
3,000 - 4,000 HP towboat	55	131	42
4,000 - 6,000 HP towboat	29	213	14
6,000 - 8,000 HP towboat	0	56	14
8,000 H.P.>	2	37	5

Source: Temple, Barker and Sloane Inc. A Guide to Strategic Planning for the Inland Barge and Towing Industry, 1985

the additions overwhelmed demand and fleet utilization rates dropped considerably. This excess supply of barges in the face of a precipitous decline in demand is the major cause of the problems facing industry today.

5.4 Cost Structure

Since the fleet in the industry consists of various sizes of towboats and types of barges, some typical ones have been selected to illustrate the cost structure. Exhibit 5.7 shows the cost structure for towboats of 1500 horsepower and 4000 horsepower and for open hopper, covered hopper and tank barges. In the case of towboats, the annual capital costs account for 10 to 40 percent of annual total costs, while the fixed annual operating costs and fuel costs account for 39 to 51 percent and 39 to 47 percent respectively. The larger towboat of 4000 hp. has higher annual capital cost and fuel cost than the smaller towboat of 1500 hp. In the case of barges, annual capital costs account for 60 to 73 percent while fixed annual operating costs account for the remaining 27 to 40 percent. No crews are used nor fuel consumed in the operation of barges, since they are pushed by the towboat. Apart from capital cost, which is the highest cost component in the barge cost structure, repairs and maintenance is the second highest cost component. This is particularly true of tank barges, because of the frequent cleaning and maintenance required as a result of carrying chemicals and petroleum products.

As discussed previously, Title XI has aided the industry by providing financing costs that are 2 to 4 percent lower than commercial loans. The impact of this financing incentive can be ascertained by considering the capital cost recovery of equipment. In this case, the towboat and barge each has an economic life of 20 years. In 1985 the commercial loan rate is assumed to be 11 percent. Under Title XI, the towboat and barge qualify for loans at 8 percent (i.e., 3 percent lower than commecial loan rate), and the size of the loans is equal to 85 percent of the newbuilding costs. At the same time, the cost of equity to the towboat and barge owner is assumed to be 35.0 percent. The weighted cost of capital after tax (r) is estimated at

Exhibit 5.7

Structure of Towboat and Barge Costs in 1985

	Towboat			Dry Barge		
	1500 HP.	4000 HP.	10,000 HP.	Covered Hopper (1500 tons)	Open Hopper (1500 tons)	Tank Barge (1500 tons)
st	1,250,000	4,000,000	8,500,000	220,000	184,000	450,000
	133,500(10%)	427,200(14%)	907,800(16%)	23,496(68%)	19,651(73%)	47,060(60%)
ing Costs	653,853(51%)	1,187,660(39%)	1,670,850(30%)	10,927(32%)	7,358(27%)	32,482(40%)
	319,200	569,000	611,000	-	-	-
	98,253	217,660	392,850	902	608	2,682
epairs	130,000	180,000	330,000	6,000	3,350	20,000
	60,000	100,000	170,000	3,000	2,625	7,600
	44,000	80,000	85,000	585	335	2,000
	2,400	41,000	82,000	440	440	200
	498,750(39%)	1,404,100(47%)	2,992,500(54%)	-	-	-
	1,286,103(100%)	3,018,960(100%)	5,571,150(100%)	34,379(100%)	26,972(100%)	80,452(100%)

r Water Resources, U.S. Army Corps of Engineers

Dc = 8%, Tax = .50, Ep = .15, and Ec = 35%). Therefore, the capital recovery factor (CRF) under Title XI is estimated at .1068 (i.e., CRF = $r(1 + r)^n/((1 + r)^n - 1)$ where r = .0865 and n = 20). This capital recovery factor of .1068 is applied to the newbuilding costs of the towboats and barges to obtain the annual capital costs shown in Exhibit 5.7.

In the absence of Title XI financing arrangements, the barge operator would have to rely on commercial loans at a rate of 11 percent (i.e., 3 percent higher than Title XI loans). Under this arrangement, the weighted cost of capital will increase to 9.925 percent while the capital cost recovery factor will increase to .1168. The percentage increase in the capital cost recovery factor is 9.36 percent and this implies that the annual capital costs shown in Exhibit 5.7 will also be 9.36 percent higher if Title XI financing is not available.

Another observation worth noting is the relationship between towboat and barge costs and rates. In depressed markets where rates are low, such as the present, barge operators may not be able to cover the full cost of owning and operating barges (i.e., long run average costs) from the prevailing rates. Under these circumstances, barge owners will continue to provide services as long as the rates do not fall below the short run variable costs (i.e., operating plus voyage less lay-up costs) of their equipment. This means that short run variable costs act as a floor on which rates can fall during depressed market conditions. If rates fall below the level of variable costs for any period of time, equipment will be laid up and the supply will be cut back. Should this continue, the supply of towboats and barges will be reduced further but, at some point, demand will begin to improve as the economic cycle bottoms out. Freight rates will then begin to move upwards as dictated by market pressure. Eventually, the shipping market will return to normal, where the vessel owner will be able to charge freight rates that will at least meet his long run average cost.

However, in the transition from depressed to normal market conditions, bankruptcies and mergers will occur and equipment will go inter-

the fleet at reduced capital costs. The impact of reduced capital costs on the overall capital cost structure of the fleet depends on the extent to which ownership of equipment has changed hands. If the ownership of significant amounts of equipment has changed hands, then the capital cost structure of the fleet would be affected and, consequently, the freight rate required to cover the long run average cost of providing barge services by the fleet would be reduced. On the other hand, if changes in ownership are limited to a few cases, then the cost structure of the fleet as well as the required freight rate would remain largely unaffected.

5.5 Current Market Condition

The current condition of the towboat and barge market in the Mississippi can only be described as depressed. The untimely investment of equipment by the industry during the late seventies and subsequent recession in the economy in 1982 have created excess capacity in the industry. With modest growth in the economy since the recession, demand on the waterway has begun to recover moderately, but the excess supply has continued to dampen rates considerably. Rates have in fact declined substantially to a level considered by many to be at short run variable costs.

Exhibit 5.8 shows the rate index for one of the main trades on the waterway, namely grain. This rate index represents the route from St. Paul to New Orleans and has 1975 as its base year (i.e., 100) when the average rate was $6.19 per ton. The index since that time has moved upwards, reaching a peak of 364 (i.e., $22.53 per ton) towards the end of the navigation season in 1979. After the peak, the index at first declined gradually and then steeply in 1986 when it reached 85 (i.e., $5.26 per ton) during the summer months. Obviously, the barge rate for grain has dropped considerably, by as much as 77 percent.

When freight rates escalated to a peak in 1979, the capacity utilization level of the barge fleet did not attain the level that triggered the period of investment in 1971 to 1974. Instead, the surge in rates was caused by short term demand from coal and grain shippers, which could not sustain

the high rates in the long run. However, independent carriers financed by outside investors saw this development differently and interpreted it as a signal for new investments. As new vessels entered the fleet, freight rates began to decline precipitously.

The low freight rates have affected carrier profitability and resulted in bankruptcies, mergers and acquisitions in the industry. However, this has not accelerated the scrappage of barges which would reduce the excess capacity. Instead, capacity has re-entered the market under new management at lower capital costs. Without a long term upsurge in demand, market conditions are likely to be depressed in the near term.

Exhibit 5.8

Average Market Rates for Heavy Grains from St. Paul to New Orleans

Month	1979	1980	1981	1982	1983	1984	1985	1986
March	-	240	187	150	149	209	130	127
April	-	166	178	170	135	151	123	115
May	-	153	150	153	129	130	98	90
June	-	187	155	145	129	126	113	90
July	307	280	140	145	146	126	108	85
August	326	338	160	147	223	144	103	150
September	276	281	215	145	157	175	123	160
October	356	335	230	146	250	165	170	193
November	364	283	210	164	245	170	178	

Note: Rates expressed as a percentage of 1975 tariff rate of $6.19 per ton

Source: Merchants Grain Exchange, St. Louis, Missouri

6. Waterway Issues and Trends

In the last few years, the Mississippi waterway has experienced a fundamental change. The U.S. economy went into a recession in 1982, and the subsequent economic recovery has been anaemic. More important still, the economic environment that exists now is quite different to the one before the recession. Then, the environment was highly inflationary and this benefited the raw materials trade and allowed barge owners the leverage to raise rates. Now, the economy has deflationary tendencies which have weakened the manufacturing sectors and dampened the raw materials trade. In addition, the untimely investment of equipment by industry in 1979 - 1981 has compounded the situation by creating an excess capacity in the fleet that as a result has depressed freight rates, eroded profit margins, and caused bankruptcies. Also, with the deregulation of rail and truck, the waterway is faced with greater competitive pressure than before, and the market share that the industry once enjoyed has been challenged. Further, the policies of Congress in support of the maritime economy, particularly the Title XI program, have come into question as companies default; this may eventually affect the prospect of low financing costs for water carriers in general, and barge carriers in particular, when industry finally remove its excess supply of vessels and requires new investments. Finally, the infrastructure on the waterway is old and its physical condition is deteriorating, and this means that the cost of maintaining the waterway will rise and that cost recovery levels may face upward pressure.

Given this background of events, there are many issues now confronting the Mississippi. How they will be resolved will signal the long term trends that may emerge. The following is an appraisal of these issues and what the likely trends will be.

6.1 The Economy

The overall health of the Mississippi waterway is, as it has always been, contingent on the strength of the U.S. economy. At this juncture, U.S. economic growth has been modest and uneven, benefiting those industries

which produce consumer goods and services while adversely affecting those industries which produce producer goods. Also, the economic recovery is now four years old and if it follows the pattern of four-year cycles in the past, then the economy is due for a recession. On the other hand the economy may be in a secular trend where cycles will be longer and more stable than in the past.

At present, the state of the economy shows no sign of shortages of goods and services and the capacity utilization of industries is low. These signs indicate that the economy has not peaked and that there is still room to expand in this cycle. At the same time, monetary policies have been accommodative (witness the progressive lowering of the discount rate and expansion of money by the Federal Reserve Board), thus ensuring adequate financial liquidity in the system. The U.S. dollar has declined significantly from its high of one and a half years ago, and signs are now emerging that import prices have begun to rise, which may eventually stem the tide of imports coming in and offer U.S. industries some relief. Furthermore, nominal and real interest rates and oil prices have declined substantially, thus reducing the cost of doing business in American industries. All these developments may be highly constructive for the future of the economy and, although, the desired effects have not materialized yet, the current period of transition is expected to lead into a broadening of economic growth. If this is the case, manufacturing sectors in the economy, particularly basic industries in steels, chemicals, and petroleum, will rise from depressed levels. The waterway's tonnages in coal, petroleum products, chemicals and other industrial commodities are likely to strengthen as a result, and the overall demand for barges, particularly open hopper and tank barges, will improve. The future demand for covered hopper barges, which are used in the carriage of grain, will not be dictated by the same factors but by the current trend in global overproduction, self-sufficiency of consuming nations, and the politics of the grain trade.

6.2 The Barge and Towing Industry

The problems of this industry, which are characterized by excess capacity and depressed rates, have led to an erosion of profits, bankruptcies, mergers and acquisitions. It would appear that the financial demise of some carriers would remove part of the surplus capacity, but this has not been the case. In fact the same equipment has been re-entering into the fleet at lower capital costs as financially stronger companies purchase this equipment at substantially reduced prices. Thus, the existing fleet capacity will remain much the same, only to be affected by natural attrition through the scrappage of old equipment. However, the scrappage of old equipment has been moving at a slow rate, since only a relatively small percentage of the fleet is over twenty years old. The excess capacity will prevail for a while, unless long term demand improves better than expected.

Although rates may be weak, the cost of operating a towboat has improved considerably as a result of the decline in fuel costs. The significant decline in the world price of crude oil from $30 to the current level of $15 per barrel in early 1986 has reduced fuel price on the Mississippi by 30 percent from 75 cents to 50 cents per gallon. Since fuel costs account for approximately 39 to 47 percent of the total cost of owning and operating a towboat annually, the decline in fuel price has reduced annual towboat costs by as much as 16 percent. The decline in costs has given industry some relief in protecting operating margins in an environment of depressed rates.

In future, the vitality of the industry will depend on how carriers restructure their fleets. Without a long term upsurge in demand, the excess capacity can only be resolved by an orderly scrappage of equipment by industry. Until such time that supply has been adjusted to meet demand, the financial condition of industry is unlikely to improve.

6.3 Infrastructure

According to the Corps of Engineers, serious problems could develop in the next decade or two in even maintaining the infrastructure to existing

levels of service. There are two major concerns, namely, inadequate lock capacity and the deteriorating physical condition of the system through age.

With regards to inadequate lock capacity, the main concerns are located at Lock 26 on the Lower Upper Mississippi and at the Gallipolis Lock on the Ohio River. These are critical locks which have become congested and resulted in significant delays. Both locks are authorized under recent legislation to be replaced. In the case of Lock 26, where a new lock (ie, other than the old Lock 26) is currently under construction, it is expected that this modern facility will be heavily used by the time it is open to traffic in 1988. Additional capacity at this facility will be required not long after the opening. As a result another lock has been authorized by Congress in 1985 and when completed, Lock 26 will have a substantially increased capacity. Other locks particularly on the Ohio River System, are also expected to be congested in the future but improvements have been authorized by Congress in fiscal year 1985.

The second major concern is the physical condition of the system. Many of the structures are now over 50 years old, and by the end of the century there will be at least 48 old and heavily used structures which will represent critical potential constraints to the system, if new projects are not carried out.

As a result, major investments will be required to modernize and maintain the waterway. These investments will be required for additions to the existing system, replacement of existing locks, major rehabilitation and repair of existing locks, and the backlog of maintenance and repair. According to the Corps, it is expected that the total investment required to maintain and improve the inland waterway system over the next 20 years will be large, probably over $5 billion, depending on the number of facilities improved and the magnitude of these improvements. Of primary concern is how these improvements will be funded. It appears that additional cost recovery measures will be introduced to offset the expense of operating and maintaining the inland waterways.

6.4 Title XI Program

The Maritime Administration (Marad) has advised Congress that there are currently about $6.8 billion in guaranteed loans outstanding for the maritime industry. The Federal Ship Financing Fund, which is used to underwrite the guarantees made under Title XI, has a total of $92 million at the present time. In 1983 and 1984, Marad had to pay off $92 million and $87 million respectively, because of a number of defaults in the industry.

Marad estimates that in 1982 alone, inland barges, towboats and supply vessels accounted for 64 percent of the $1.2 billion in total guarantees issued that year. Although previous years' estimates were not available, it is believed that the sums involved were not dissimilar. Due to the easy availability of loan guarantees, it has been alleged that Title XI has contributed to the serious overtonnaging on the inland waterways. In particular, the program financed many of the barges purchased by investor groups and also by overextended and underfinanced companies.

Now that the inland barge and towing industry is in serious difficulty, concerns are mounting that the number of defaults will increase substantially and that the Fund is underfinanced to pay off its obligations. The administration of the Fund by Marad has come under severe criticism and Congress has taken steps to limit the amount of guarantees issued each year in progressive stages. If this trend continues over time, then inland carriers in future will not be able to depend on Title XI as a source of cheap financing. This means that the cost of owning equipment on the waterway may rise in future for newly built vessels.

Furthermore, since the Fund is underfinanced, Marad is attempting to assist the industry from defaulting by undertaking investigations to improve the operating efficiency of the fleet as a means of keeping carrier costs down and improving operating margins. While this is well intended, the effects will only prolong the problem of excess capacity in the industry, instead of overcoming it.

6.5 Competing Modes

In addition to the problems mentioned above, the Mississippi waterway is also facing competition from alternative modes, particularly the rail mode. A deregulated rail industry is in a strong economic position to pose a continuous competitive challenge in future, especially in view of the trend toward mergers into fewer and larger networks and the way the industry has successfully weathered the recent recession. Furthermore, the use of long-term contracts and unit trains in dedicated service has given the rail mode another competitive edge.

In addition to rail, pipelines are another mode which competes with the Mississippi, particularly in liquid commodities such as oil and petroleum products. Although capital costs for rights-of-way and construction are initially high, they are generally offset by low operating costs in the longer term.

By way of illustrating the advantage of alternative modes compared to the waterway, Exhibit 6.1 shows the ranking of modal characteristics in terms of cost, flexibility, capacity and speed.

Exhibit 6.1

Comparative Advantages of Modes

Linehaul Speed	Flexibility	Capacity	Cost(1)
Truck- 10 to 60 mph	Truck- Can provide "door-to-door" service to almost any inland point	Pipeline- 30,000 to 2,500,000 ton unit capacity	Pipeline- .3 to 1.0 cents/ton-mile
Rail- 20 to 45 mph	Rail- Rail sidings permit "door-to-door" service between many inland ports	Water- 1,000 to 60,000-ton unit capacity	Water- .3 to 3.0 cents/ton-mile
Water- 3 to 10 mph	Water- Range of direct service is geographically limited to areas adjacent to a waterway	Rail- 50 to 12,000-ton unit capacity	Rail- 1.0 to 8.0 cents/ton-mile
Pipeline- 3 to 6 mph	Pipeline- Can offer direct service only to those mechanically lined to the system	Truck- 10 to 25-ton unit	Truck- 4.0 to 15.0 cents/ton-mile

Source: U.S. Army Corps of Engineers, Institute for Water Resources National Waterways Study: Overview of the Transportation Industry Report Prepared by A. T. Kearney, Inc., August 1981.

(1) 1977 Dollars

7. Implications for Canadian Transportation

As a major exporter of grains, coal, potash, sulphur, lumber products and other commodities, Canada has traditionally relied on the western route by rail to British Columbia ports, the eastern route by rail and lake vessel to the Gulf of St. Lawrence, and, to a much lesser extent, the northern route by rail to the Port of Churchill as the main distribution channels. The extent to which these routes have been used in the past is a measure of how shippers have perceived the comparative advantage in rates and logistics of these routes. Underlying the perception by shippers and their decision on route-choice in the past have been the particular policies of government with respect to rail subsidies and the development of infrastructure such as port facilities.

In the last few years, major developments in transportation have taken place that may change the environment considerably. Among these developments are the secular change in the Canadian economy, passage of the Western Grain Transportation Act in 1983, current proposed legislation to foster greater competition between and within transport modes, and the pursuit of free-trade with the U.S. Although the effects of these developments are not fully felt at the present time, the new environment could cause a significant shift in the way western Canadian shippers of grain, potash and other bulk commodities have historically perceived the relative advantage of the western, eastern and northern export routes.

In this regard, the weak state of the western Canadian economy and the deflationary pressure on commodities may force an acceleration of events. Rapidly falling prices in commodities, particularly grain, create significant downward pressure on producers' margins, which in turn will force producers to cut costs. Since the incidence of transport cost on bulk commodities is relatively high, producers are likely to include transportation as part of their cost reduction measures. If this turns out to be the case, shippers are likely to turn their attention to the Mississippi River as a potentially low cost route. At a time when barge rates in real terms are at

a historical low, the attraction of the Mississippi route can be a decisive factor. Already, nearly 1.5 million tons per annum of potash from Saskatchewan move on the waterway, mainly to U.S. markets and to a much smaller extent to markets in Latin America such as Brazil.

Access to the head of navigation at Minneapolis-St. Paul from western Canada is provided by the Burlington Northern Railway and the Soo Line Railway which is owned by Canadian Pacific Ltd. In particular, Winnipeg is connected to Minneapolis/St. Paul (distance of approximately 450 miles) by either the Canadian National Railway or the Canadian Pacific Railway with an interchange at Emerson, Manitoba (near the international border) to the Burlington Northern Railway or the Soo Line Railway. At Minneapolis-St. Paul, bulk commodities can be stored in terminals for transit, or directly loaded onto a 15-barge tow for the downbound journey to the Gulf. According to terminal operators in the summer of 1986, terminal charges for transhipment at Minneapolis-St. Paul are quoted to be in the range of $1.75 to $2.50 per ton. Barge operators quote rates to New Orleans in the month of August, 1986 at $9.30 per ton, while during the opening of the season in March, 1986, rates were quoted at $7.90 per ton. At New Orleans, the terminal charge for transhipment is also quoted to be the same as Minneapolis, that is $1.75 to $2.50 per ton. Using the high end of these rates, the total rate for this movement is about $14.30 per ton (this corresponds to about Canadian $21.85 per ton). As noted in Exhibit 5.8, barge rates can fluctuate greatly during the navigation season. Generally, in a given season, the rate during the opening of the season is low and it increases rapidly towards the end of the season, which also coincide with the grain harvesting period. For the 1986 season especially, barge rates started out weakly but accelerated significantly during the summer as the U.S. government announced major grain sales to the Soviet Union.

Canadian shippers who contemplate the use of the Mississippi route because it is perceived to be an economic route should address two issues: first, whether the comparative advantage in favour of the Mississippi is long term or short term; and, second, whether shipments can be easily redirected to a Canadian route if the Mississippi advantage disappears.

On the first question, the answer depends on the dynamics of the Mississippi River system. Most observers consider that market conditions in the barge and towboat industry have deteriorated to a point where the bottom of the shipping cycle has been reached. How long this bottoming of the cycle will last is not clear, but at some point market conditions will improve and rates will begin to rise. Market forces are already at work in a direction where the overtonnaging of today will lead to shortages tomorrow. There are many signs that point to this conclusion: the problem of excess capacity has been recognized and scrappage of the fleet (although at a rather slow rate) has been acknowledged as one constructive way of adjusting supply downward to meet demand; general economic conditions are likely to improve and the economic recovery will broaden out to manufacturing sectors whose recovery will translate to firmer demand for raw materials to be transported on the waterway; the significant drop in world oil price to $10 a barrel is now consolidating at $15 a barrel and possibly moving moderately upwards over time so that the beneficial effects of low fuel cost will deteriorate as time progresses; the low financing scheme offered by Title XI, which has been sharply criticized for poor management, are likely to be tightened up so that the availability of easy finance will not contribute to the overinvestment of fleet capacity in future; and, finally, the large investment required to modernize and maintain the infrastructure on the waterway will pressure Congress to authorize higher cost-recovery levels so that user charge on the waterway will increase. Some of these signs point to a better barge market tomorrow, while others indicate greater cost pressure on the industry. In sum, the trend in rates is likely to move up in the long term although there are no durable signs of dramatic improvement in the short term.

Given that the long term trend in rates on the Mississippi will move upwards, the issue of whether the waterway is still more advantageous will depend on the way the transport environment in Canada will evolve and whether it will lead to a more competitive environment with competitive rates as intended in the new policy directions. In this regard, the shipper must understand not only the dynamics of the Mississippi waterway but also

the new transport environment in Canada before he can make a decision as to which route is most advantageous in the long run.

The second question is more difficult to address since the answer will be contingent on the practices of the shipper, the volume of shipment involved, the timing of the switch back to a Canadian route and the particular market environment at the time, and whether carriers who have written off their equipment as a result of traffic lost will be willing to respond to the new demand. An observation worth noting in this regard is that the time when the Mississippi becomes unattractive to a shipper is likely to be the time when rates have risen substantially. Rising rates are typical of peak market conditions and, therefore, other routes may experience similar conditions at the same time. As a result, the shipper may not escape the prospect of paying high freight rates. Each shipper, however, will have his own appraisal of the risks associated with the strategy he takes.

If Canadian traffic should be diverted to the Mississippi in future, there will be costs and benefits to the Canadian economy. The nation as a whole will be better off if the economic benefits exceed the costs. The gainers (shippers) and losers (carriers) will come from different parts of the country, and as a result the impacts in the short term will affect the population differently. However, in the long run, the distributive effects through the economy will set in and the nation could be better off by the change from the status quo. On the other hand, if the net benefits as a result of the change are negative, then the economy would be better off with existing arrangements.

Finally, by way of concluding, this report has attempted to provide an understanding of the dynamics of the Mississippi River System and a qualitative appraisal of the trends that are about to emerge. The report has not attempted to analyse the comparative cost advantage of the Mississippi waterway in relation to Canadian routes, and indepth work is required in this important area in future. In this context, the present work can be perceived

as a building block for future work which will lead to a better understanding of Canada's competing distribution channels.

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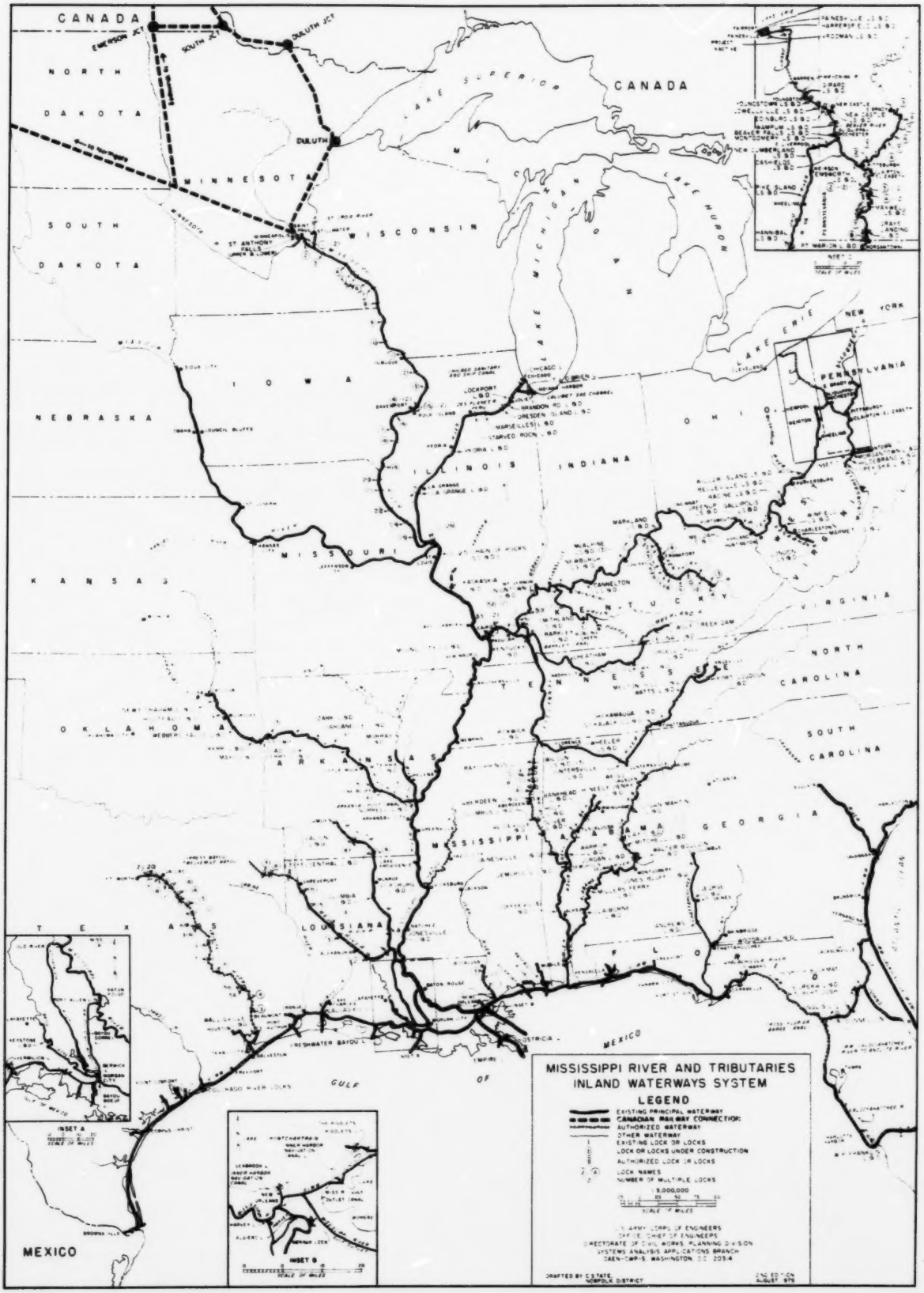
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